Three Essays on Sovereign Debt and Financial Markets

by

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Abstract

This dissertation analyzes different aspects of the actions of borrowing and repaying debts by governments in both domestic and international financial markets.

In Chapter 1, which is co-authored with Guido Sandleris and Alejandro Van der Ghote, we use a unique dataset on sovereign bond issuances and syndicated bank loans to study the duration and determinants of the periods of exclusion from international credit markets that usually follow governments' defaults. Among other results, we find that countries either reaccess the markets in the first years after a default or have to wait much longer to do it, and that political stability significantly increases the chances of reaccessing the market. We present a political economy model of endogenous sovereign borrowing and market reaccess that matches these two features of the data.

In Chapter 2, I study the relation between the domestic financial system's market structure, the allocation of government debt and the cost of credit for the government. The fact that governments are less likely to repudiate their debts when there are more domestic agents among their creditors creates an externality: when domestic investors demand government bonds, they reduce the probability of default and improve the situation of every other bondholder. The concentration of investment decisions in fewer financial institutions increases the degree of internalization of this effect, expands the demand for government bonds by domestic agents and reduces the cost of credit for the government.

In Chapter 3, I propose a mechanism that can explain the observed positive correlation between public and private spreads, taking into account that domestic banks tend to be heavily exposed to sovereign debt. Firms have private information about the results of their projects, information that can be obtained by domestic banks, as long as they pay a verification cost, but not by foreign creditors. A sovereign default has a negative impact on domestic banks, reduces their verification capacity and increases the incentives for firms to declare themselves insolvent. Consequently, risks of sovereign and private defaults are positively correlated.

Thesis Supervisor: Guido Lorenzoni
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[1]**This chapter is the result of joint work with Guido Sandleris and Alejandro Van der Ghote, both from Universidad Torcuato Di Tella.**

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Chapter 1

Sovereign Defaults and the Political Economy of Market Reaccess[1]

1.1 Introduction

Following its sovereign default in 1982 Dominican Republic did not reaccess international credit markets for more than twenty years. After defaulting on that same year, Turkey immediately regained access. Why does it take some countries a long time to reaccess the market following a sovereign default while others do it without any delay? This paper analyzes this issue empirically and presents a political economy model of sovereign defaults that matches key empirical findings.

Sovereign governments are immune from bankruptcy procedures and few of their assets can be seized in the event of a default. However, sovereign defaults are not costless. The sovereign debt literature has analyzed theoretically a number of channels through which defaults are costly and, as a result, sovereign borrowing can be sustained. Eaton and Gersovitz (1981) in a seminal paper have argued that the exclusion from international credit markets can enforce repayment.[2]

In this paper we document the duration of the period of exclusion from international credit

[1] **This chapter is the result of joint work with Guido Sandleris and Alejandro Van der Ghote, both from Universidad Torcuato Di Tella.**

[2] Trade sanctions, reputation spillovers and information revelation have been other mechanisms studied in the literature to explain the costs of sovereign defaults. See Bulow and Rogoff (1989), Cole and Kehoe (1997) and Sandleris (2008) for example.

markets that sovereigns face after a default and analyze empirically its determinants.[3] We then present a DSGE model of endogenous sovereign borrowing that rationalizes our novel empirical findings on the political factors that influence market reaccess.

In order to study the duration of the periods of exclusion, being able to pinpoint with precision the year in which a government is able to reaccess the market is crucial. We use a unique micro dataset on international bond issuances and borrowing through private syndicated loans from non-domestic banks by sovereign governments that allows us to do it. This data, provided by Capital Data Bondware and Loanware, includes issuances and loans for 150 developing countries between 1980 and 2000. Having access to this detailed microdata constitutes a distinctive feature of our paper. In order to identify the default date we use, as most of the literature does, Standard & Poor's database on sovereign defaults on foreign-currency debt.[4] During this period we identify 101 sovereign default events according to Standard & Poor´s database.

In order to study the pace at which countries that defaulted reaccess international credit markets, we perform a duration analysis. A duration analysis is one of the two possible approaches to study this issue. An alternative approach is to measure the time elapsed between the start of a default episode and the date of reaccess, obtaining then statistics about the distribution of exclusion periods across episodes. On the other hand, the duration analysis, studies the probability of reaccessing the credit market in each period after the start of the default episode, given that reaccess was not obtained before and regardless of whether reaccess will be obtained in the future. While the alternative approach requires an "end-point" for each episode and can only incorporate positively resolved default episodes (where reaccess was obtained), our approach, the duration analysis, has the advantage of allowing us to include both episodes in which reaccess has already occurred and episodes in which it has not.

Our main empirical findings are that:

- countries either reaccess the markets in the first six years after a default or have to wait much longer to do it;

[3]We assume that if a country does not reaccess the market after a default, it is because the country is unable to do so. Of course, we are aware that there could be situations in which the country chooses not to do it. In order to avoid including these latter type of events in our analysis we follow the strategy of Gelos et al (2011).

[4]See for example, Tomz and Wright (2007), Arteta and Hale (2008) or Gelos et al (2011).

- political stability significantly increases the chances of reaccessing the market in any given period after the default;

We also find that reaccess is faster when countries are larger, wealthier and being perceived as implementing better policies, and when the world economic situation is better. On the contrary, the countries' liquidity situation, openness, and the existence of an IMF program do not seem to be significant in explaining market reaccess. Comparing across decades in which the default occurred, we find that it is easier to reaccess the markets in the 1990s than in the 1980s as long as the country does it quickly (in the first three years), but the probability of having been able to reaccess within the first four, five or six years is higher in the 1980s.

In order to rationalize the first two empirical findings, we present a DSGE model with endogenous sovereign borrowing, default and reaccess related to Aguiar and Gopinath (2006), Arellano (2008) and Yue (2010). In particular, our model extends Andreasen et al (2011) to include the role of political economy considerations in the market reaccess issue. As in Andreasen et al (2011), we assume that households are heterogeneous (in terms of income) and that governments need to garner some amount of political support to implement fiscal policies needed to repay foreign debts. However, we extend this model to take into account the need to obtain political support also to settle a default and reaccess the market.

A key assumption in our model that allows us to match the empirical findings is that countries differ in the level of political support required to implement the fiscal program required to reaccess the markets. In particular, we assume that there are two groups of countries, those with a high degree of political stability (low political support requirement) that manage to regain access quickly, and those with a low degree of political stability for whom exclusion tends to last a much longer time.

Our paper is also related to the empirical literature on the costs of sovereign defaults, which is not as rich as the theoretical one, particularly in relation to the inability of governments to borrow after a default. Gelos et al. (2011) study the determinants of market access but do not focus on access after defaults as we do. Arteta and Hale (2008) study the effects of sovereign defaults on credit to the private sector. Dias and Richmond (2007) analyze the determinants of the duration of the exclusion as we do, but they measure the start of this period at the date of settlement while we do it at the date of default. Another difference with this paper is that they do not have access to detailed micro data on sovereign borrowing, so they cannot define the reaccess date as precisely as we do.

The paper is organized as follows. Section 2 discusses the data and presents our empirical strategy. Section 3 shows the main empirical results of the paper. Section 4 presents the model. Section 5 concludes.

1.2 Data and Empirical Strategy

We identify sovereign defaults using the S&P database. We determine the year of market reaccess following each default through a unique micro dataset on international bond issuances and borrowing through private syndicated loans from non-domestic banks by sovereign governments. The dataset, provided by Capital Data Bondware and Loanware, contains information on 2053 individual bond issuances and 5065 commercial bank syndicated loans to national governments (or with government guarantee) from 150 developing countries between 1980 and 2000. During this period we identify 101 sovereign defaults from S&P's database, 68 of which occurred in countries that had access to the credit markets at least once during the whole period.

Using microdata allows us to capture the year of market reaccess with much more precision than using only aggregate data. Although the literature has often focused exclusively on bonds, it is important to include syndicated bank loans in the analysis too, as we do, since they were the prominent form of sovereign borrowing by developing countries during the 1980s.

We define market access as public or publicly guaranteed international bond issuances or borrowing through a private syndicated bank loan occurring in a year in which the country's indebtedness increases. This definition aims to exclude cases where a sovereign's borrowing capacity falls but the country is still able to roll over part of its debt, which implies that the government is, in net terms, repaying and not borrowing. In order to check whether the country's indebtedness actually increases when we observe a bond issuance or bank loan in the micro data, we use data on debt stocks from the World Bank's Global Development Finance database.

When we measure the time elapsed between a default declaration and market reaccess, which allows us to include only countries that were able to regain access at some point during our sample (which finishes in 2000), we find, consistently with Gelos et al (2011), that it takes more time to re-enter the market when the default takes place in the 1980s (4.5 years) than in the 1990s (2.9 years).

Table I: Time of Exclusion (By Decade)

Decade	Episodes	Mean
1980s	29	4.5
1990s	10	2.9
All	**39**	**4.1**

However, this result is biased. The fact that the sample is cut in 2000 implies that we would be comparing a group of default episodes for which market reaccess was obtained within the starting decade or the following one (1980s) with a group of default episodes for which reaccess was obtained within the starting decade (1990s). The problem would remain if we just expanded the sample and is caused by the fact that this approach cannot include episodes for which reaccess did not occurred.

In order to be able to include all default episodes, both those for which reaccess was obtained and those for which it was not, we implement a duration analysis approach. A fundamental variable in this methodology is the probability of reaccessing the credit market in any given period k, computed as the ratio between the number of episodes in which reaccess is obtained k years after the start of the default -e_k- and the number of episodes that have arrived to the beginning of this period without reaccess occurring before -n_k-, denominated hazard rate. A key indicator constructed with this probability for different periods is the Survival Function, which indicates the probability of still being out of the market after a given number of periods after the start of the default.

$$S(t) = \prod_{k=1}^{t} \left(1 - \frac{e_k}{n_k}\right)$$

where $S(t)$ is the survival function, e_k denotes the number of reaccess in period k and n_k the number of individuals events still in the sample in that period.

Table II presents the probability of not having reaccessed the market by each year after the start of the default episode. First, it shows that the median time of exclusion from the credit market is of five years for the whole sample. When comparing between decades, it shows that countries regain market access with higher probabilities in the 1990's during the first three years of the default episode, but find it more difficult to re-enter the market if they have not regained access during these first three years. By the third year after the default episode, 41% of the countries have regained market access if the default episode happened in the 1990s, while only 32% of them have regained it if the default episode happened in the 1980s. However, if we look at the fifth year, the numbers are reversed: 53% are back in the market for defaults in the 1980s and only 41% for defaults in the 1990s.

Table II: S(t) (probability of not having regained access)[5]

Years after default	1980s	1990s	All
1	0.84	0.83	0.84
2	0.75	0.66	0.73
3	0.68	0.59	0.65
4	0.58	0.59	0.58
5	0.47	0.59	0.50
6	0.40	0.51	0.43
7	0.40	0.51	0.43
8	0.40	0.51	0.43
# default episodes	**45**	**23**	**68**

In the appendix we show tables for these Survival Functions by decade and region. African countries have lower probabilities of reaccessing the market and Emerging Europe countries have higher ones, for both decades. However, countries from Latin America and the Caribbean jump from having lower probabilities than the average in the 1980s to having higher ones in the 1990s.

Whenever a country does not access the credit markets in a given year after a default, we interpret it as an inability to access the market. However, we could be facing an identification problem, as a government's lack of borrowing in a given period could arise either from the creditors not wanting to lend (the supply side) or because the sovereign does not want to borrow

[5]For countries that have access at some point, either before or after the default episode.

(the demand side). The ideal strategy to deal with this identification problem would be to estimate demand and supply curves separately. However, there are well-known methodological problems associated with such techniques. Because of the kind of countries considered, we believe that this identification problem is not a big issue in this paper. Countries that default must have accumulated significant foreign debts, suggesting they are trying to fund investment and consumption levels above their current production capacity. Moreover, at the time of default, they are probably not able to increase their net foreign borrowing to avoid the costs associated with debt repudiation without having to reduce domestic consumption. It is true that the need for foreign funds might be reversed with time, but we believe this usually does not happens closely after the default.

The duration model we use to analyze which factors affect the speed at which countries that have defaulted on their foreign debts are able to reaccess credit markets has time-varying covariates. We estimate the effect of explanatory variables in the following equation:

$$h\left(t\right) = h_0\left(t\right) \exp\left(\beta_1 x_1 + ... + \beta_{kt} x_{kt}\right)$$

where t is the number of periods transcurred since the start of the default episode, $h(t)$ is the hazard function (probability of regaining access in t), $h_o\left(t\right)$ is the baseline hazard, x_1 represents a constant explanatory variable and x_{kt} represents a time-varying explanatory variable.

Our baseline regression includes the following variables which try to capture countries' capability and willingness to repay, as well as a punishment that the market could impose according to the context in which the default occurred:

- The present economic situation of the country, which we measure through the growth rate of GDP, gives a signal about the perspectives for the future and the country' capability to repay.

- The size of a country can affect its ability to access the credit market. For example, the potential punishment that can be imposed through sanctions and collateral seizure is larger for larger countries. In addition, there might be fixed costs for borrowing through syndicated loans or bond issuances, which could force smaller countries to access the markets less frequently. We use population as a measure of size.

- Political instability may adversely affect the investment climate, the government's capability to collect revenues and, therefore, its ability to repay. We measure political risk by the International Country Risk Guide's (a higher value denotes lower risk)

- A country's economic links with the rest of the world can affect the cost of default and, therefore, its ability to borrow. This is captured by the ratio of exports plus imports to GDP (openness).

- We include an index of Country Ratings published by Institutional Investors, based on assessments of about 100 large commercial banks to reflect long term expectations formed by the market about the country. In this case, we do not include GDP per capita, as there might be a continuity between policies implemented in the past and expected to be implemented in the near future.

- The growth rate of GDP the country was experiencing at the time of repudiating its debts. This gives an idea of how "necessary" and how strategic was the decision to default and helps to figure out if markets have memory and punish for opportunistic repudiation.

- Multilateral assistance can help countries overcome liquidity problems and act as a "seal of approval" of sound economic policies. Therefore, we include the presence of a non-concessional IMF program, which can take the form of Stand-By Arrangements (SBA) or Extended Fund Facilities (EFFs).

- A country's liquidity. We use the level of external reserves to months of imports as an indicator of liquidity.

- GDP per capita indicates the potential punishment that con be imposed on the country and the capacity to overcome fixed borrowing costs, as well as the soundness of policies the country has being implementing in the past.

- Control variables are needed in panel estimations to abstract from global shocks that affect countries over time. We control for global factors using the average GDP growth rate for the G-7 countries and the decade in which the default episode occurred.

All macro variables are taken from the WEO or IFS database. We also run a number of alternative specifications including the following variables:

- The ratio of exports to GDP, which indicates how much the country will loose if banned from placing its products abroad, as a potential punishment for not repaying its debts, and also gives an idea of the country's capacity to raise foreign currency. We do not include openness in the regression in this case.
- The 6-month LIBOR in real terms.
- Regional Dummies.

The year at which S&P considers the default as being resolved is not included in this list, because we consider it is endogenous to variables mentioned above, as Institutional Investors' Ratings and Political Stability.

1.3 Main Results

In Table III we present the results using the Institutional Investor rating as an indicator of the long term expectations the market forms about the kind of policies the country will implement in the future. We can see that variables that indicate the short-run economic situation of the country (GDP growth, Exports/GDP, Reserves/Months of Imports) do not affect significantly the probability of the defaulting country to regain market access. The fact that the default episode started in the 1980's does not affect this probability either, confirming our previous finding that, when considering both solved and not solved default episodes, it does not take significantly longer to come back if you defaulted in the 1980's than in the 1990's. The presence of an IMF program is not significant either. Countries that defaulted in times of relatively higher economic activity do not seem to be significantly punished by their opportunistic behavior.

In the group of significant variables, we find that countries with larger populations have higher chances of reaccessing the market, indicating the presence of fixed costs of borrowing or that it is important for lenders to have the possibility of imposing bigger sanctions. Countries with lower political risk have higher chances of re-accessing the market too. A possible explanation for this result is that a country with lower political risk is one where the government is perceived as being more capable to implement fiscal policies that might be required to guarantee debt repayment in the future. This finding is stressed by the significance of the Institutional Investor's ratings variable, which captures whether policies are perceived as sound. The presence of an IMF program does not affect the probability of reaccessing the market, although this has to be qualified by the fact that the Institutional Investors' rating might be affected by this presence. Finally, concerning the situation of the global economy, we see that defaulting countries present higher probabilities of regaining market when the developed world is growing faster (the LIBOR interest rate is not significant, as shown in the appendix).

Table III: Results Using Institutional Investor

	(I)	(II)
GDP Growth	-0.0092	-0.0085
	[0.0117]	[0.0117]
Population	0.0054	0.0050
	[0.0025]**	[0.0026]*
Political Risk	0.0143	0.0149
	[0.0062]**	[0.0061]**
G7 GDP Growth	0.1379	0.1405
	[0.0607]**	[0.0606]**
Exports/GDP	-0.3554	
	[0.3886]	
Growth at Default	-0.0059	-0.0072
	[0.0070]	[0.0071]
IMF Non-Con Agreement	-0.0625	-0.0458
	[0.0968]	[0.0988]
Institutional Investor	0.0115	0.0119
	[0.0061]*	[0.0059]**
Openness		-0.3289
		[0.2177]
Started in 1980's	0.0605	0.0129
	[0.1624]	[0.1651]
Reserves/Months of Imports	-0.0165	-0.0247
	[0.0247]	0.0252
# of subjects (episodes)	101	101
# of exits (re-access)	39	39
Time at risk	703	703
Log likelihood	-74.385	-73.601
Observations	387	387

Table IV shows the results using GDP per capita, instead of the Institutional Investors ratings, to assess the quality of policies countries' have been taking and are probably expected to continue taking in the future. The results remain unchanged for all variables mentioned before. We see that a higher level of GDP per capita is also positively related with a higher probability of reaccessing the credit market after a default episode. It is interesting that the presence of an IMF program is not significant even when we do not include market perceptions among the explanatory variables.

Table IV: Results Using GDP Per Capita

	(III)	(IV)
GDP Growth	-0.0088	-0.0086
	[0.0103]	[0.0102]
Population	0.0052	0.0049
	[0.0024]**	[0.0024]**
Political Risk	0.0102	0.0113
	[0.0059]*	[0.0059]*
G7 GDP Growth	0.1500	0.1532
	[0.0610]**	[0.0616]**
Exports/GDP	-0.2589	
	[0.3281]	
Growth at Default	-0.0050	-0.0051
	[0.0069]	[0.0071]
IMF Non-Con Agreement	-0.1023	-0.1011
	[0.0935]	[0.0959]
GDP Per Capita	0.0001	0.0001
	[0.0000]**	[0.0000]**
Openness		-0.2227
		[0.2033]
Started in 1980's	0.0283	0.0024
	0.1639	0.1695
Reserves/Months of Imports	-.0029	-0.0059
	[0.0178]	[0.0180]
# of subjects (episodes)	101	101
# of exits (re-access)	39	39
Time at risk	703	703
Log likelihood	-80.342	-79.983
Observations	458	458

We show in the appendix that the only significant regional dummy is the one corresponding to Europe.

1.4 The Model

In this section, we present a DSGE model of endogenous sovereign borrowing that rationalizes our empirical findings on the timing of market reaccess and the political factors that affect it. The two key empirical findings that our model rationalizes are the following:

- politically stable countries have higher chances of reaccessing international credit markets
- defaulting countries tend to concentrate in two groups: those who return to international credit markets relatively fast (within six years) and those that are excluded for very long periods of time

In the model, we assume that governments are benevolent and can borrow from abroad. Sovereign debt is defaultable and non-collateralized. In the event of default, the government is excluded from international credit markets and, in addition, suffers some output loss. In order to reaccess international credit markets after a default, the government needs to make a payment to settle with foreign creditors.

The novel feature of the model is that we introduce political economy considerations in relation to the market reaccess issue. As in Andreasen et al (2011), we assume that households are heterogeneous (in terms of income) and that governments need to garner some amount of political support to implement fiscal policies needed to repay foreign debts. However, we extend this model to take into account the need to garner political support also to settle a default and reaccess the market. So, in our model, the government will only make a payment to foreign creditors when doing so: 1) maximizes aggregate welfare and 2) is beneficial for a critical fraction of the population (50%, for example, if it was subject to a referendum).

The asymmetry across countries in terms of chances of reaccess is obtained by defining two types of countries: politically stable and politically unstable ones. In politically stable countries, the political support requirements to implement a policy are lower than in unstable ones. That is, it is easier to implement policies in the former group of countries than in the latter. The rational for this assumption is that countries where governments find it harder to pass fiscal austerity measures to repay debts, tend to be countries where people are used to protest more often and which have frequent episodes of civil unrest and government collapses in their history. That is, they tend to be more politically unstable countries.

In the following subsections we present and solve the model and show how these ingredients are enough to rationalize our empirical findings.

1.4.1 Environment

Consider a small open economy inhabited by a continuum of households and a benevolent government. Households are heterogenous in terms of income, but all of them are risk averse and have the same preferences. Each household's income is equal to $y_i^r = \alpha_i y$, where α_i is the constant share of the aggregate endowment y that household i receives. The aggregate endowment follows a Markov process with transition density $f(y', y)$ defined on a compact subset $Y \subset \mathbb{R}_+$. Households derive utility from consumption:

$$U(c_i) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it})$$

where the function $u(c)$ denotes the strictly concave and increasing Bernoulli utility function and β refers to the subjective discount factor.

The government is benevolent and maximizes social welfare, which is defined as the sum of utility levels across individual households. Formally:

$$W = \int_{\Omega} E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}) di$$

where Ω refers to the households' population set, which has unit measure.

The government is the only agent within the small economy who has access to international credit markets. In each period, the government issues one period zero-coupon bonds and sells them to the foreign lenders. We denote by B' the amount of debt that the government has issued in the current time period and that promises a payment to bond holders of B' units of consumption in the following period. If $B' < 0$ the government is a debtor, otherwise it holds assets. When the government issues debt, it obtains $B'q(B',y)$ units of current consumption.[6]

Sovereign bonds are assumed to be non-collateralized and defaultable. To repay its outstanding debt, the government proposes a fiscal program, i.e. a combination of new bond issuances, B', and lump sum taxes τ, that households have to approve or reject.[7][8] For the government to be able to repay the debt, there must exist a fiscal program that satisfies two conditions. First, the fiscal program must generate enough resources. That is, given outstanding debts B issued in the previous period, the government must be able to issue new bonds, B', and to set taxes, τ, such that:

$$\tau - B'q(B',y) \geq -B \tag{1.1}$$

Second, the fiscal program must garner sufficient support from individual households. Households express their approval or rejection for a given fiscal program through a referendum (i.e. voting for or against the program). Given current aggregate output y, the political support function that collects the households' approval over a fiscal program (B',τ) proposed by the government is defined as:

$$p(B',\tau;y) = \int_{\Omega} p_i(B',\tau;y)\,di \tag{1.2}$$

where $p_i = 1$ if household i votes in favor of the fiscal program and $p_i = 0$ otherwise.[9] The fiscal program will be approved only if:

$$p(B',\tau;y) \geq p^r \tag{1.3}$$

where $p^r \in [0,1]$ refers to the minimum level of households' approval required to implement a

[6] The symbol $q(B',y)$ refers to the unitary price of sovereign bonds given current aggregate output endowment, y, and the amount of debt to be issued, B'.

[7] As households cannot have negative consumption, we restrict the lump sum taxes not to exceed the income of the poorest household, i.e.:

$$\tau \leq \min_{i\in\Omega} y_i^r = y_{\min}^r$$

With some additional notation, one can think of $y_{\min}^r$ as the income of the household with lowest income among those that pay taxes.

[8] As in Andreasen et al. (2011), the critical issue is that the after tax income differs across households.

[9] We assume individual households responses to be equally weighted within the political support aggregator mechanism.

fiscal program.

When there are fiscal programs that satisfy the resource constraint, (1.1) , and the political constraint, (1.3), the government is able to repay. However, in spite of being able to repay, the government might still choose not to do. If the government defaults, regardless of the cause, it is temporarily excluded from international credit markets. While in autarky, the economy suffers an output loss in its aggregate endowment. Specifically, households consume their individual financial autarky endowments, y_i^d, defined as:

$$y_i^d = \alpha_i h(y) \leq y_i^r$$

where $h(y)$ stands for the output loss function.

The exclusion period is endogenous in our model, which constitutes a key difference with Andreasen et al (2011). In order to regain access to international credit markets, the government has to repay an exogenous recovery rate η over its previously defaulted debts. To do so, it has to propose a fiscal program specifying the amount of new debt it will issue in international credit markets and the level of lump sum taxes that it will impose on households.

For the government to be able to regain access to these markets, there must exist a fiscal program (B', τ) that satisfies:

$$\tau - q\left(B', y\right) B' \geq -\eta B \tag{1.4}$$

$$p\left(B', \tau; y\right) \geq p^d \tag{1.5}$$

where $p^d \in [0, 1]$ stands for the political support threshold the government faces when sovereign bonds that were in default are repaid. If the government is able to reenter credit markets, it has to choose whether to do it or to stay in default.

The political support threshold is the key variable that relates our previous empirical findings and this theoretical model. We assume that the government needs a higher or equal approval level than the one with which past decisions were made (i.e. $p^d \geq p^r$). In addition, we assume that countries with high values of p^d, where governments find it hard to pass fiscal austerity programs to repay defaulted debts, tend to be countries where people are used to protest more often and which have frequent episodes of civil unrest and government collapses in their history. That is, they tend to be more politically unstable countries.

Foreign lenders have risk neutral preferences, behave competitively and have access to the sovereign bond and to a risk-free asset that yields $r > 0$. They are willing to lend to the government as long as they break even in expected value. Foreign lenders are fully aware of the political economy constrains the government faces. Besides, they recognize the government's incentives to default on these contracts. As a result, in equilibrium, the sovereign bond price perfectly captures the sovereign default risk prevailing in the economy.

1.4.2 Value Functions and Recursive Equilibrium

The timing of events in an economy that is current on its payments is as follows. At the beginning of each period, the current aggregate endowment, y, is observed, and, given the amount of sovereign debt, B, the government proposes a fiscal program (B', τ) or it declares a default. If the government proposes a fiscal program that raises at least B resources, each household then decides whether to approve or reject the proposal.[10]

Households' individual responses are aggregated by the political support function, $p(B', \tau; y)$. If the political support exceeds the threshold p^r, and generates enough funds, the government can implement the fiscal program and repay the debt. Otherwise, the government is forced to default. After all these decisions are made, consumption takes place. If the government defaulted, household i consumes her financial autarky output endowment, y_i^d. If the government repaid, consumption for household i is $y_i^r - \tau$.

The government is excluded from international credit markets for at least one period following a default, independently of the reason that caused it. The timing of events while the economy is in financial autarky is similar to the timing described above. First, the aggregate endowment y is observed and, given the amount of the payment required to settle the default and reenter the markets, ηB, the government proposes a fiscal program, (B', τ), or it postpones the repayment. If the government proposes a fiscal program that raises at least ηB resources, each household then decides whether to approve or reject the proposal. Household's individual

[10] For simplicity, we assume that households cannot enter into cooperative arrangements, and that the government cannot commit to ex-post transfers to compensate households.

responses are aggregated by the political support function, $p(B', \tau; y)$. If their aggregated political support exceeds the threshold p^d, the government can implement the proposal and repay the past defaulted debts. Otherwise, the government must stay in financial autarky. After all these decisions are made consumption takes place. If the government repays its defaulted debt, consumption for households is $y_i^r - \tau$, while if the government postpones the repayment, their consumption is y_i^d.

Government's problem

In every period in which the government is current on its debt, depending on the level of outstanding debt and on the aggregate income shock, the government may be able or unable to repay the debt. Let $v_g^0(B, y)$ be the value function for the government at the beginning of the period:

$$v_g^0(B, y) = \begin{bmatrix} v_g^d(B, y) \text{ if } \nexists (B', \tau) \text{ with } \tau \leq y_{\min}^r : (1.1) \text{ and } (1.3) \text{ hold} \\ v_g^a(B, y) \text{ otherwise} \end{bmatrix}$$

where $v_g^d(B, y)$ and $v_g^a(B, y)$ refer to the value of being unable and able to repay, respectively. The value function of being able to repay, $v_g^a(B, y)$, is given by:

$$v_g^a(B, y) = \max_{\{r,d\}} \left\{ v_g^r(B, y), v_g^d(B, y) \right\} \tag{1.6}$$

where $v_g^r(B, y)$ is the value associated with repayment.

When the government repays, it must be the case that its fiscal program satisfies its budget constraint, raising enough funds to honor current debts, and that it achieves enough political approval across households. The government´s value function of repaying satisfies:

$$\begin{aligned} v_g^r(B, y) &= \max_{(B', \tau)} \int_\Omega u(y_i^r - \tau)\, di + \beta \int_Y v_g^0(B', y') f(y', y)\, dy', && (1.7) \\ & \quad \text{subject to } (1.1) \text{ and } (1.3) && (1.8) \end{aligned}$$

and the fiscal program it proposes is the solution to this problem.

When the government defaults, regardless of whether the default was the result of the government being unable or unwilling to repay, the economy is excluded from international credit markets. Formally, this value is given by:

$$v_g^d(B,y) = \int_\Omega u\left(y_i^d\right) di + \beta \int_Y v_g^{00}(B,y') f(y',y)\, dy'$$

where $v_g^{00}(B,y)$ denotes the government value function in financial autarky at the beginning of the period. In a similar fashion as when the government has access to credit markets, this value function satisfies:

$$v_g^{00}(B,y) = \left[\begin{array}{l} v_g^d(B,y) \quad \text{if } \nexists (B',\tau) \text{ with } \tau \leq y_{\min}^r : (1.1) \text{ and } (1.3) \text{ hold} \\ v_g^{aa}(B,y) \text{ otherwise} \end{array}\right.$$

where $v_g^d(B,y)$ equals the value of being unable to reenter, and hence of postponing the reentry too, and $v_g^{aa}(B,y)$ is the value of being able to reenter. From the government perspective, the value of postponing the payment of B defaulted bonds equals the value of defaulting B bonds. In both cases, in the current time period households consume their financial autarky endowment while in the next period the government can only return to credit markets by repaying the amount $|\eta B|$ demanded by foreign lenders. To avoid introducing more notation, we use the same value function of default, $v_g^d(B,y)$ to refer to both values.

When the government is able to reenter, it has to decide whether to return to credit markets or to postpone its repayments. The value function $v_g^{aa}(B,y)$ is given by:

$$v_g^{aa}(B,y) = \max_{\{d,rr\}} \left\{ v_g^d(B,y); v_g^{rr}(B,y) \right\}$$

where $v_g^{rr}(B,y)$ stands for the value of returning to credit markets.

When choosing to repay its past defaulted bonds, the government solves:

$$\begin{aligned} v_g^{rr}(B,y) &= \max_{(B',\tau)} \int_\Omega u\left(y_i^r - \tau\right) di + \beta \int_Y v_g^0(B',y') f(y',y)\, dy', \\ &\quad \text{subject to } (1.4) \text{ and } (1.5) \end{aligned} \tag{1.9}$$

We characterize the default set $D(B)$ and repayment set $R(B)$as:

$$D(B) = \left\{ y \in Y : \begin{array}{l} \text{if } \nexists (B', \tau) \text{ with } \tau \leq y^r_{\min} : (1.1) \text{ and } (1.3) \text{ hold} \\ \text{or } v^r_g(B, y) < v^d_g(B, y) \end{array} \right\}$$

and as:

$$R(B) = \left\{ y \in Y : v^r_g(B, y) \geq v^d_g(B, y) \right\}$$

and the proposed fiscal program $(B'(B, y), \tau(B, y))$ to repay nondefaulted debts solves (1.7)

Equivalently, the staying excluded set $S(B)$ and reentry set $RR(B)$ are defined as:

$$S(B) = \left\{ y \in Y : \begin{array}{l} (1.4) \text{ or } (1.5) \text{ do not hold } \forall (B', \tau) \text{ with } \tau \leq y^r_{\min} \\ \text{or } v^{rr}_g(B, y) < v^d_g(B, y) \end{array} \right\}$$

and as:

$$RR(B) = \left\{ y \in Y : v^{rr}_g(B, y) \geq v^d_g(B, y) \right\}$$

and the proposed fiscal program $\left(\tilde{B}'(B, y), \tilde{\tau}(B, y)\right)$ to repay defaulted debts solves (1.9)

Households' problem

Households maximize their utility by choosing whether to approve or to reject the government funding proposal. A household that rejects the proposal wants the government to default (or not to settle its default), while a household that approves it wants the government to repay or settle a preexistent default. Let $p_i(B', \tau; y)$ be the optimal voting decision for household i, given current output, y, and the government funding proposal (B', τ):[11]

$$p_i(B', \tau; y) = \left[\begin{array}{l} 1 \text{ if } v^r_i(B', \tau; y) \geq v^d_i(B, y) \\ 0 \text{ if } v^r_i(B', \tau; y) < v^d_i(B, y) \end{array} \right. \quad (1.10)$$

where 1 stands for voting in favor and 0 for voting against, and $v^r_i(B', \tau; y)$ and $v^d_i(B, y)$ are the value functions, from household i perspective, of the government repaying by implementing a fiscal program (B', τ) and defaulting (or postponing a defaulted debt repayment), respectively.

[11] We assume that indifferent households approve the government proposal.

Formally, the former value function is given by:

$$v_i^r(B', \tau; y) = u(y_i^r - \tau) + \beta \int v_i^0(B', y') f(y', y) dy' \tag{1.11}$$

while the latter by:

$$v_i^d(B, y) = u\left(y_i^d\right) + \beta \int v_i^{00}(B, y') f(y', y) dy' \tag{1.12}$$

where v_i^0 $\left(v_i^{00}\right)$ denotes the value, from household i point of view, of living in an economy where the government has (does not have) access to international credit markets.

Since households anticipate the government behavior, $v_i^{00}(B, y)$ and $v_i^0(B, y)$, are given by:

$$v_i^{00}(B, y) = \left[\begin{array}{ll} v_i^r\left(\tilde{B}'(B, y), \tilde{\tau}(B, y); y\right) & \text{if } y \in RR(B) \\ v_i^d(B, y) & \text{if } y \in S(B) \end{array} \right. \tag{1.13}$$

$$v_i^0(B, y) = \left[\begin{array}{ll} v_i^r(B'(B, y), \tau(B, y); y) & \text{if } y \in R(B) \\ v_i^d(B, y) & \text{if } y \in D(B) \end{array} \right. \tag{1.14}$$

Foreign lenders' problem

Foreign lenders understand the government's incentives and constraints when they decide to lend to the government. Since they behave competitively and have risk-neutral preferences, the expected return of lending to the government should equal the risk free interest rate. This implies that the sovereign bond price satisfies:

$$q(B', y) = \frac{1 - \Pr[D(B') | Y = y]}{1 + r} + \frac{\Pr[D(B') | Y = y]}{1 + r} E\left[\frac{\eta}{(1 + r)^{\tau(Y^\infty; B', Y')}} | D(B')\right]$$

The function $\tau(y^\infty; B, y)$ refers to the government optimal reentry time to credit markets following a (B, y)-default episode. Formally, this function is a Stopping Time and is defined as:

$$\tau(y^\infty; B, y) = \min\left\{t \in \mathbb{N} : v_g^{rr}(B, y_t) \geq v_g^d(B, y_t)\right\}$$

where $y^{\infty} \in \times_{t=1}^{\infty} Y$. The first term in the RHS of the sovereign bond pricing equation denotes the market-value probability of a repayment event while the second one refers to the market-value probability of a default event times the expected present value of the recovery rate on defaulted debts.

To end this section, we define the Recursive Equilibrium for our model economy.

1.4.3 Recursive Equilibrium

Definition 1 *A Recursive Equilibrium for this economy is i) a policy set for the government when having access to credit markets,* $\{B'(B,y), \tau(B,y); D(B); R(B)\}$, *when being excluded from these markets,* $\left\{\tilde{B}'(B,y), \tilde{\tau}(B,y); RR(B); S(B)\right\}$; *ii) a household's support strategy* $p_i(B', \tau; y)$; *iii) a sovereign bond price function* $q(B', y)$ *and a political support function* $p(B', \tau; y)$ *such that:*

1. *Given the sovereign bond price function and the political support function, the government's policy set* $\{B'(B,y), \tau(B,y); D(B); R(B)\}$ *solves the government´s optimization problem when having access to credit markets and the government's policy set* $\left\{\tilde{B}'(B,y), \tilde{\tau}(B,y); RR(\right.$ *solves the government's optimization problem while in financial autarky.*

2. *Given the government's policy sets, the households' strategies* $p_i(B', \tau; y)$ *satisfy the households' optimization problem.*

3. *The sovereign bond price function* $q(B', y)$ *is consistent with the government's policy sets and satisfies the foreign lenders' break even condition.*

4. *The political support function* $p(B'; B, y)$ *is consistent with households' support strategies.*

1.4.4 Quantitative Analysis

Calibration

We calibrate the model to the Argentine 2001 default episode using a quarterly frequency. We choose a CRRA functional form for the Bernoulli utility function:

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}$$

with a coefficient of relative risk aversion σ equal to 2. The aggregate output endowment is assumed to follow an AR(1) stochastic process:

$$\ln y_t = \rho \ln y_{t-1} + \varepsilon_t$$

with $|\rho| < 1$ and $\varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$. To estimate these parameters, we use GDP data taken from the Ministry of Finance (MECON) ranging from the first quarter of 1980 to the second quarter of 2001. The GDP time series is in quarterly frequency, in real terms and seasonally adjusted; it is logged and then detrended using a linear filter. Our estimates of ρ and σ_ε are 0.945 and 0.025, respectively.

A relevant feature of our analysis is how we calibrate households income heterogeneity. We do it using the Argentine income distribution in 1998 as measured by the Center for Distributive, Labor and Social Studies (CEDLAS).[12] This is the first year for which they provide information corresponding to the whole country. We assume that aggregate output is distributed across three different types of households (poor, middle income and rich) according to:

Table V. Shares in Aggregate Output

α_1	α_2	α_3
12%	34%	54%

where α_1 equals the average share among deciles 1, 2, 3 and 4, α_2 equals the average among 5, 6, 7 and 8 and α_3 the average of the remaining two deciles.

In line with standard models, we choose an asymmetric output loss function as in Arellano (2008):

$$h(y) = \min\{y, (1-\lambda) E(Y)\}$$

where $E(Y)$ stands for the aggregate output unconditional mean and λ refers to the percentage aggregate output loss during a sovereign default episode.

The subjective discount factor β, the re-entry to credit markets probability θ and the percentage aggregate output loss λ are set as in Arellano (2008) for comparability.[13] Finally, the

[12] The CEDLAS is an independent research organization at the Universidad de La Plata, Argentina.

[13] Arellano (2008) uses a θ consistent with the empirical findings of Gelos et al (2010) and sets λ and β to match in her model the standard deviation of the current account and the ratio of debt service to GDP.

risk-free interest rate r is set to 1.7%, just to equal the average quarterly interest rate of a 5 year U.S. treasury bond from the first quarter of 1980 to the second quarter of 2001.

Table II summarizes this discussion:

Table VI. Parameter Values

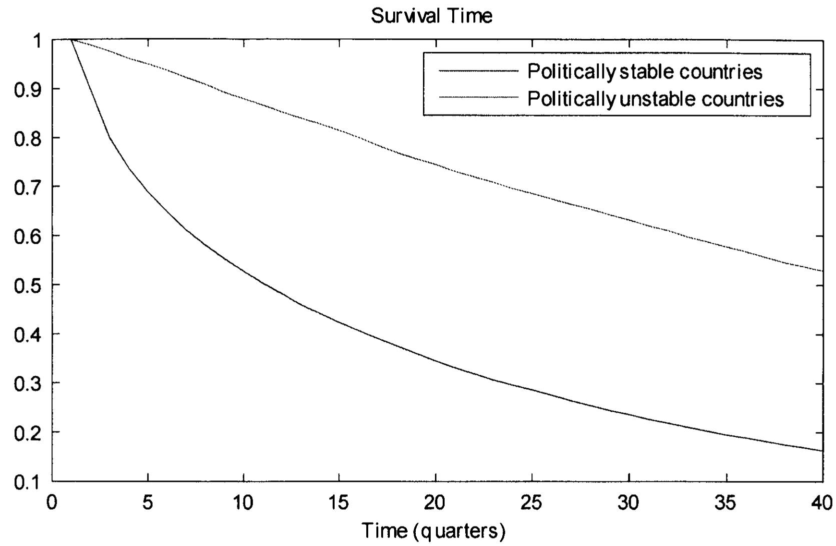
σ	ρ	σ_ϵ	β	θ	λ	r
2	0.945	0.025	0.953	0.282	0.96	1.7%

Simulation results

The thresholds p^d and p^r are essential in our model. These parameters measure the extent by which the government can raise funds to repay defaulted debts and nondefaulted debts, respectively. In political stable economies, where social unrest and government collapses are very rare, we assume that a default episode does not really tighten the political constraints that the government faces. As a result, in these economies, we assume that the government requires almost the same approval when raising funds to repay nondefaulted debts as when raising funds to repay past defaulted debts. In contrast, in political unstable economies, a default event may trigger a sharp rise in the political requirements the government needs to meet to repay its debts. In particular, the political turmoil triggered by a default episode restricts the government to reach higher households approval levels to settle a preexistent default.

In our simulation experiments, we focus in the extreme case where a default event does not alter political constraints at all in stable economies, so that $p_s^d = p^r$, but turns these constraints as stringent as possible in unstable economies, i.e. $p_u^d = 1$. Given our proposed calibration, in the former economies the government requires the approval of a simple majority to return to credit markets, while in the latter the government needs unanimity.

Figure I displays the model simulated survival time for both political stable and unstable economies. As evidenced in this Figure, after three years from a default episode, only 30% of the political stable economies but as much as 75% of the political unstable ones remain excluded from credit markets. This result is in line with our empirical findings that political stability makes it more likely to reaccess the markets and that countries either regain market access in the first few years after a default or it takes them a long time to do it. In the model these results are explained by the difference in political constraints across countries. More stable countries



are more likely to reaccess quickly but it can take unstable countries a long time to do it.

In our model, in both kinds of economies a default episode happens when current output is below its trend level. Yet, while in political unstable economies the government has to wait for "very good" times to get the reentry approval from all households, in political stable economies the government might reenter credit markets in "normal" times, as it only requires the approval from a simple majority of households. Because extremely good outcomes only happen rarely, political unstable economies take significantly more time to reenter credit markets. Our model states that the reentry time difference across economies of the same type is merely due to the output recovery following a default event. Economies in which output recovers faster reentry occurs more rapidly.

1.5 Conclusions

This paper analyzed the determinants of the duration of the exclusion from international credit markets following a sovereign default using micro data on sovereign debt issuances abroad and syndicated loans. This data allowed us to pinpoint with precision the date of reaccess.

Our empirical analysis uncovered a number of interesting regularities. We found that countries either reaccess the markets in the first six years after a default or it takes them a much longer time to do it, and that political stability significantly increases the chances of reaccessing the market in any given period after the default. We presented a political economy model of market reaccess following a default that allowed us to account for these regularities.

Another interesting finding of our paper is that the time of exclusion is lower in the 1990's if reaccess is achieved within the first three years after the default, but it turns out to be higher if reaccess is not achieved by then. Consequently, it cannot be said that reaccess is generally harder in one decade or the other. This finding contradicts previous studies that find that market reaccess has become much easier in the 1990s.

Finally, we also found, as expected, that larger and wealthier countries have higher chances of reaccessing international credit markets after a default episode, and that better global conditions enhance the chances of reaccess.

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1.6 Appendix

Table A: Countries that never had access

Country	**Default Episodes**
Albania	1991
Antigua and Barbuda	1996
Bolivia	1980, 1986, 1989
Bosnia and Herzegovina	1992
Burkina Faso	1983
Cape Verde	1981
Central African Republic	1981, 1983
Congo, Rep.	1983
Dominican Republic	1982
Gambia, The	1986
Guinea-Bissau	1983
Guyana	1982
Haiti	1982
Honduras	1981
Liberia	1987
Malawi	1982, 1988
Mauritania	1992
Mozambique	1983
Myanmar	1997
Senegal	1981, 1990, 1992
Sierra Leone	1983, 1986
Togo	1982, 1988, 1991
Uganda	1980
Zambia	1983
24	**33**

Table B: Countries that had access before but didn´t regain access

Country	Default Episodes
Algeria	1991
Cote D ´Ivoire	2000
Ecuador	1999
Ethiopia	1991
Gabon	1986, 1999
Guinea	1991
Indonesia	1998, 2000
Jordan	1989
Kenya	1994
Madagascar	1981, 1986
Moldova	1998
Niger	1983
Nigeria	1986, 1992
Pakistan	1998, 1999
Paraguay	1986
Russian Federation	1998
Seychelles	2000
Tanzania	1984
Ukraine	1998
Yugoslavia	1983, 1992
20	**26**

Table C (First Part): Countries that had access before and regained access

Country	Default Episodes	Market Re-Access
Angola	1985	1986
Argentina	1982	1986
Argentina	1989	1994
Brazil	1983	1984
Bulgaria	1990	2000
Cameroon	1985	1988
Chile	1983	1994
Costa Rica	1981, 1984	1998
Cote D'Ivoire	1983	1994
Croatia	1992	1995
Ecuador	1982	1987
Egypt	1984	1988
Ghana	1987	1991
Guatemala	1986, 1989	1995
Iraq	1987	1988
Jamaica	1981	1983
Jamaica	1987	1997
Macedonia	1992	1998
Mexico	1982	1985
Morocco	1983	1985
Morocco	1986	1988
Peru	1980	1982
Peru	1983	1996

Table C (Second Part): Countries that had access before and regained access

Country	Default Episodes	Market Re-Access
Philippines	1983, 1992	1994
Poland	1981	1982
Romania	1981, 1986	1990
Russian Federarion	1991	1992
Slovenia	1992	1993
South Africa	1985	1988
South Africa	1989	1990
South Africa	1993	1994
Trinidad and Tobago	1988	1994
Turkey	1982	1983
Uruguay	1983, 1988, 1990	1992
Venezuela, RB	1983	1988
Venezuela, RB	1990	1992
Venezuela, RB	1995	1996
Vietnam	1985	1990
Yemen	1985	1986
39	**43**	**39**

Table D: S(t) (probability of not regaining access, complete)

Period	All
1	0.84
2	0.73
3	0.65
4	0.58
5	0.50
6	0.43
8	0.43
9	0.43
10	0.36
11	0.29
12	0.29
13	0.24
14	0.19
16	0.19
17	0.19
# of cases	**68**

Table E: S(t) in the 80's by region

Period	All	Latin America	Africa	Middle East	Europe	Asia
1	0.84	0.95	0.85	0.67	0.6	1
2	0.75	0.84	0.85	0.33	0.6	1
3	0.68	0.77	0.69	0.33	0.6	1
4	0.58	0.71	0.62	0.17	0.4	1
5	0.47	0.50	0.62	0.17	0.4	0.5
6	0.4	0.35	0.62	0.17	0.4	0.5
7	0.4	0.35	0.62	0.17	0.4	0.5
8	0.4	0.35	0.62	0.17	0.4	0.5
# of cases	**45**	**19**	**13**	**6**	**5**	**2**

Table F: S(t) in the 90's by region

Period	All	Latin America	Africa	Middle East	Europe	Asia
1	0.83	0.75	0.83	1	0.78	1
2	0.66	0	0.83	1	0.78	0
3	0.59		0.83	1	0.58	
4	0.59		0.83	1	0.58	
5	0.59		0.83	1	0.58	
6	0.51		0.83	1	0.39	
7	0.51		0.83	1	0.39	
8	0.51		0.83	1	0.39	
# of cases	**23**	**4**	**6**	**1**	**9**	**3**

Table G: Results with Libor

	(I) Con GDPPC y Libor	(II) Con II y Libor
GDP Growth	-0.0099	-0.0125
	[0.0094]	[0.0109]
Population	0.0057	0.0055
	[0.0020]***	[0.0023]**
Politicasl Risk	0.0097	0.0143
	[0.0057]*	[0.0063]**
G7 GDP Growth	0.1090	0.2027
	[0.0714]	[0.0883]**
Exports/GDP	-0.1353	-0.1511
	[0.2757]	[0.3550]
Growth at Default	-0.0034	-0.0041
	[0.0056]	[0.0059]
IMF Non-Con Agreement	-0.1095	-0.0634
	[0.0899]	[0.0933]
GDP Per Capita	0.0001	
	[0.0000]**	
Institutional Investor		0.0083
		[0.0049]*
Started in 1980's	0.0625	0.1200
	[0.1658]	[0.1679]
Libor	0.0075	-0.0565
	[0.0483]	0.0548
Log likelihood	-93.555	-82.123
Observations	484	398
LR chi2(10)	33.16	31.40
Prob > chi2	0.0003	0.0005

Table H (First Part): Results with Regional Dummines

	(I)	(II)	(III)	(IV)	(V)
GDP Growth	-0.0098	-0.0092	-0.0107	-0.0074	-0.0098
	[0.0094]	[0.0099]	[0.0094]	[0.0094]	[0.0096]
Population	0.0057	0.0059	0.0054	0.0067	0.0057
	[0.0020]***	[0.0021]***	[0.0021]**	[0.0022]***	[0.0020]***
Politicasl Risk	0.0096	0.0088	0.0100	0.0085	0.0092
	[0.0057]*	[0.0064]	[0.0058]*	[0.0058]	[0.0058]
G7 GDP Growth	0.1163	0.1018	0.1130	0.1004	0.1157
	[0.0548]**	[0.0537]*	[0.0545]**	[0.0524]*	[0.0547]**
Exports/GDP	-0.1294	-0.1034	-0.1411	-0.1996	-0.1637
	[0.2812]	[0.2695]	[0.2751]	[0.3189]	[0.2950]
Growth at Default	-0.0034	-0.0024	-0.0037	0.0006	-0.0022
	[0.0057]	[0.0055]	[0.0057]	[0.0067]	[0.0061]
IMF Non-Con Agreement	-0.1081	-0.1028	-0.1110	-0.1057	-0.1320
	[0.0924]	[0.0879]	[0.0894]	[0.0917]	[0.0992]
GDP Per Capita	0.0001	0.0001	0.0001	0.0001	0.0001
	[0.0000]**	[0.0000]*	[0.0000]**	[0.0000]**	[0.0000]**
Started in 1980's	0.0695	0.0605	0.0472	0.2840	0.0566
	[0.1632]	[0.1580]	[0.1619]	[0.2125]	[0.1642]
Latin America	-0.0013				
	[0.1009]				

Table H (Second Part): Results with Regional Dummines

	(I)	(II)	(III)	(IV)	(V)
Africa		-0.1381			
		[0.1183]			
Asia			0.1654		
			[0.2357]		
Europe				0.3876	
				[0.2069]*	
Middle East					0.1124
					[0.1862]
Log likelihood	-93.567	-92.753	-93.347	-92.014	-93.399
Observations	484	484	484	484	484
LR chi2(10)	33.14	34.77	33.58	36.25	33.48
Prob > chi2	0.0003	0.0001	0.0002	0.0001	0.0002

Chapter 2

Financial Markets' Concentration and Demand for Government Debt

2.1 Introduction

Financial institutions in emerging markets tend to hold a lot of domestic public debt in their balances, which exposes people whom savings they manage and themselves to domestic and, more specifically, to sovereign risk. Why do they do this? Is it a non-optimal choice they have to make because of the pressure the government puts on them or are there other reasons that makes them voluntarily do so? The purpose of the paper is to show that, independently of the pressure put by governments, there are reasons why financial institutions that represent many individual domestic investors might optimally choose a portfolio with more domestic public debt than what the individual investor would choose if acting on his own. Moreover, bigger institutions have more incentives to hold government debt, so concentration in the financial system leads to a higher domestic demand for government debt.

This paper is related to the sovereign debt literature, but attempts to address a different question than the ones written before. The main branch of the sovereign debt literature studies why governments repay their debts. A more recent and empirical branch analyzes which particualr mechanisms are more relevant to match stylized facts observed in the relations between governments and their creditors. In this paper I look at how interest rates and government debt allocation among domestic and foreign agents are influenced by institutional features of the domestic financial system. Some of these institutional features are, for example, the presence of investment banks and hedge funds as agents that manage small investors' portfolios, in opposition to an environment in which these investors take the allocation decisions on their own. It will be shown that it is important whether there are few of them that concentrate a large fraction of the funds in the market or these funds are spread around many institutions. It will be also important if there are mechanisms that allow and encourage the coordination of the investment decisions of these institutions. As an example, Chile and many other Latin American Countries with private social security systems penalize funds whose rate of return deviates from the industry average (James 2005), which gives them an incentive to replicate each others portfolios.

Other papers in which the incentives of governments to follow certain policies are different if those affected are domestic or foreign agents are Kremer and Mehta (2000), Tirole (2003) and Broner and Ventura (2005). Tirole (2003) highlights the externality created by this fact and analyzes the imposition of restrictions on foreign capital flows as a mechanism to alleviate a commitment problem by the government. In this paper, I show how the institutional features of the domestic financial system work to alleviate a similar commitment problem by the government, now in the context of sovereign debt.

The government decides, in this model, whether to repay its debt or not, without being able to separate among creditors. Debt holders include agents the government cares about (domestic creditors) and agents the government does not care about (foreign creditors). A higher participation of domestic agents among creditors gives the government more incentives to repay its debt. Therefore, by holding government's debt, each domestic decreases the chance of default and reduces the interest rate, exerting a positive externality on other domestic agents. When the investment decisions of domestic agents are not coordinated, this externality is not taken into account at the time of deciding how much government debt to purchase and the participation of domestic creditors among debtholders is lower. However, if domestic agents delegate their portfolio choices to financial institutions, which would be large enough to internalize the effect, the participation of domestic creditors among government bondholders increases. This reduces the chances of default and the interest rate paid by the government, and increases the home bias in the portfolio of domestic agents.

2.2 Evidence

In this section, I analyze the portfolio choices of financial institutions in Colombia, Italy and the US, as representatives of countries with high, intermediate and low risk, respectively. In 2006, Colombia's rating was Baa3 (2.03% country risk premium), Italy's rating was Aa2 (0.75% country risk premium) and US's rating was Aaa (0% country risk premium)[1]. The prediction in the paper is that financial institutions will allocate a larger share of their portfolios in government bonds relatively to households in countries with higher risk, because their is more scope to influence the government's behavior. The evidence presented below support the prediction.

An alternative explanation would be that the government puts pressure on financial institutions, to make them demand bonds, and that this pressure is higher in riskier countries. This concern should be less important for the case of Colombia, used in the paper as the representative of risky countries, because of the free-market orientation of its government in 2006.

I use Private Pension Funds (PPF) as representatives of financial institutions in the country. The choice is based on two key characteristics they have. The first one is that their mission is to choose the best portfolio, in terms of return and risk, for the agents whose wealth they manage, the same objective households have when they manage their portfolios by themselves. The second characteristic of Private Pension Funds is that they represent the interest of many small investors, which gives them a lot of political power to influence the government's decisions. In this sense, they have more power than institutions that manage the same amount of resources coming from fewer investors, because of their relevance for electoral results that determine the continuation of a political party in government.

Developed and developing countries differ in many aspects that influence portfolio choices, such as the size of the stock market or the risk aversion of agents, for example. That is the reason why I follow the approach of first comparing between different groups of agents (PPF and households) within each country, as a way of controlling for country effects, and only afterwards do the comparison between countries. I look at how biased towards government bonds are PPFs with respect to households, and then compare this bias along countries.

The countries are chosen because of data availability. In the case of Colombia, apart from

[1]Data from Aswath Damodaran's (NYU Stern) web page.

publicly available data on Flow of Funds that can be found in the website of Banco de la República, I used information specially provided by the Economic Information Office (Dirección Técnica y de Información Económica) of this institution. The indicators for Italy and the US were prepared using the Financial Accounts and the Flow of Funds that can be found at the websites of Banca D'Italia and the Federal Reserve, respectively. All data is for the year 2006.

2.2.1 Portfolios in a country with high risk: Colombia

Colombia has a Private Social Security System in which workers deposit their social security contributions in a Pension Fund of their choice, which administer them until retirement. As shown below, domestic government bonds have a very large share (42.9%) of Private Pension Funds' portfolios. This choice is not explained by regulatory norms, because PPF in Colombia have upper bounds on the type of assets they can invest in (50% of portfolio for domestic government bonds, for example), but not lower bounds. The free market orientation of Colombia's government reduces the concerns about this decision resulting from government's pressure rather that free choice.

In table 1, we see the different assets in Private Pension Funds' portfolio as % of Total Financial Assets excluding currency and monetary deposits. Domestic Government Bonds represent 42.9%.

Table 1: Private Pension Funds' Portfolios in Colombia

Savings and Time Deposits	16.8%
Domestic Government Bonds	42.9%
Corporate and Foreign Bonds	18.8%
Stocks and Shares	6.2%
Trade Credit and Other Accounts Receivable	7.3%
Other Assets	8.0%
Total	100%

Table 2 shows the composition of portfolios chosen by households. Domestic Government Bonds represent 20 times less in these portfolios than in those chosen by Private Pension Funds. It is true that the higher participation of Savings and Time Deposits, probably because they are easier to access, reduces the participation of other financial instruments as well, but the decrease in government bonds is more pronounced. For example, government bonds are 7 times more important than stocks in pension funds, while they are only one fifth of stocks in households.

Table 2: Households' Portfolios in Colombia

Savings and Time Deposits	59.9%
Domestic Government Bonds	2.0%
Corporate and Foreign Bonds	0.7%
Stocks and Shares	9.7%
Trade Credit and Other Accounts Receivable	20.2%
Other Assets	7.5%
Total	100%

2.2.2 Portfolios in a country with intermediate risk: Italy

In the case of Italy, an additional methodological step was necessary. As in the case of the US, Mutual Fund Shares are a significant component of portfolios, so I projected the "indirect" holdings of government bonds and stocks for the different agents by analyzing their participation in mutual funds, and included these holdings in the items presented in the tables.

Table 3: Private Pension Funds' Portfolios in Italy

Savings and Time Deposits	9.1%
Domestic Government Bonds	24.8%
Corporate and Foreign Bonds	21.5%
Stocks and Shares	24.2%
Trade Credit and Other Accounts Receivable	0%
Insurance	4.4%
Other Assets	14.2%
Total	100%

We see that Private Pension Funds allocate a lot of their resources in domestic government bonds and are more biased towards them than Households, although the contrast is not as big as in Colombia, as shown in section 2.4.

Table 4: Households' Portfolios in Italy

Savings and Time Deposits	10.5%
Domestic Government Bonds	5.3%
Corporate and Foreign Bonds	13.7%
Stocks and Shares	30.1%
Trade Credit and Other Accounts Receivable	2.4%
Insurance	16.6%
Other Assets	4.4%
Total	100%

2.2.3 Portfolios in a country with low risk: the US

In the case of US, government bonds represent a significantly smaller fraction of Private Pension Funds' portfolios than in Colombia or Italy. As shown below, most of the funds are invested in stocks and credit market instruments of the private sector.

Table 5: Private Pension Funds' Portfolios in the US

Savings and Time Deposits	2.6%
Domestic Government Bonds	4.4%
Corporate and Foreign Bonds	5.3%
Stocks and Shares	67.3%
Credit Market Instruments	12.5%
Other Assets	8.0%
Total	100%

The menu of assets available in the US is larger than in Colombia or Italy, so the comparison with how households behave in the same country is even more necessary. US households also have access to a larger menu of assets, but we don't observe in this country the relative bias of private pension funds towards government bonds. In fact, households hold more domestic government bonds than private pension funds in their portfolios.

Table 6: Households' Portfolios in the US

Savings and Time Deposits	19.0%
Domestic Government Bonds	6.0%
Corporate and Foreign Bonds	4.5%
Stocks and Shares	59.7%
Credit Market Instruments	10.5%
Other Assets	0.3%
Total	100%

2.2.4 Comparison between countries

Table 7 presents the share of domestic government bonds in total financial assets (without money) allocated by private pension funds and households. The first two rows correspond to numbers already shown and the third one is the ratio between the number for pension funds and the number for households. This last row shows how biased towards government bonds are Private Pension Funds in comparison with Households in each country. Consistently with the theory proposed in the paper, according to which institutional investors hold bonds in order to improve the behavior of the government and their return, the bias is more pronounced in riskier countries, where it is more important and there is more room to influence the government. In the case of the US, where there is no default risk in government bonds, the bias disappears.

Table 7: Government Bonds Participation

Government Bonds / Financial Assets	**Colombia**	**Italy**	**US**
Private Pension Funds	42.9%	24.8%	4.4%
Households	2.0%	5.3%	6.0%
PPF / Households	21.7	4.7	0.7

Table 8 leads to the same conclusion using a different indicator: the ratio of government bonds to stocks and shares. The purpose is to account for the fact that some households might not have access to the purchase of government bonds, which is a valid concern in the case of Colombia, and this is done by comparing bondholdings with holdings of other assets that also require more than basic access to the financial markets. As in table 7, the bias towards government bonds is higher when the country is riskier.

Table 8: Government Bonds Relative to Stocks

Government Bonds / Stocks and Shares	Colombia	Italy	US
Private Pension Funds	6.97	1.02	0.07
Households	0.20	0.17	0.10
PPF / Households	34.12	5.85	0.64

2.3 The Model

2.3.1 Environment

There are 2 periods and 5 types of agents: the government, foreign investors, a mass 1 of domestic agents born in period 1, a number $\frac{1}{c}$ of financial institutions and a mass 1 of domestic agents born in period 2.

The government maximizes social welfare. In period 1, it borrows qB, where q is the price of the bond and B is the number of bonds issued, each of which pays 1 in $t = 2$. With this resources, the government implements a project that carries a utility AqB with certainty in period 2 to every domestic agent. At the beginning of period 2, the government has to decide whether to repay or repudiate its debt, which is held by both foreign investors and domestic agents born in period 1 (generation 1). If it decides to repay, it does so by collecting taxes from domestic agents born in period 2 (generation 2). If it decides not to repay, generation 2 does not pay taxes but loses a fraction λ of its income. Generation 1 is hurt by a default decision because it receives no payments for the debt it holds.

Foreign investors are risk neutral and have access to public bonds and a safe investment technology that pays the international interest rate 1. In case the government decides to repay public debt in $t = 2$, they receive $1 - m$ for each bond they held, where $0 < m < 1$ is a capital mobility cost.[2]

Domestic agents born in period 1 receive and income y_1 and deposit it completely in the financial institutions, which invest it in the agents' best interest. The agents are risk averse and consume all their income in $t = 2$.

[2]The variable m is introduced so as to have both risk neutral (foreign) and risk averse (domestic) agents demanding more than 0 bonds, which wouldn't occur if expected returns were equal for both groups.

Each financial institution receives a share c of total savings. They allocate resources between the same 2 saving technologies available to foreign investors: the public bond and the safe international asset. They act, basically, as portfolio managers.

2.3.2 Foreign Investors

The model assumes that domestic agents don't have enough wealth to acquire all the bonds issued by the government, so some of them will be in the hands of foreign agents. As they are risk neutral, the no-arbitrage condition sets the price of the bond (q), where p is the probability that government debt will be repaid.

$$\frac{p}{q}(1-m)=1$$

2.3.3 Generation 1

All domestic agents receive the same income y_1 in $t=1$ and delegate the investment decision to financial institutions. As all agents are equal and financial institutions invest maximizing the agents' expected utility, it is valid to assume that all of them will hold the same portfolio. Financial institutions allocate a fraction $0<\alpha<1$ of the representative agent's income in government bonds and the rest in the safe technology. There's no income in $t=2$ for generation 1, other than the returns from investments made in $t=1$, so expected utility is

$$E(U_1)=pU_1\left[\frac{\alpha y_1}{q}+(1-\alpha)\,y_1\right]+(1-p)\,U_1\left[(1-\alpha)\,y_1\right]$$

For convenience, so as to have expected utility only in terms of the expected return and variance of the portfolio, we will assume a quadratic utility function.[3][4]

$$U_1(C_1)=aC_1-bC_1^2$$

Consequently

[3] As the distribution of payments is not normal but binomial (repay fully or nothing), this couldn't be obtained by using an exponential utility function.

[4] I will make the necessary assumptions about the parameters of the model to guarantee that the marginal utility of consumption is always positive.

$$E(U_1) = ay_1\mu_\alpha - by_1^2\left[V_\alpha + (\mu_\alpha)^2\right]$$

where μ_α is the expected return for a given α

$$\mu_\alpha = \alpha\frac{m}{1-m} + 1$$

and V_α is the variance for a given α

$$V_\alpha = \alpha^2\frac{(1-p)}{p(1-m)^2}$$

2.3.4 Government

The government takes 2 decisions. At $t = 1$, how much debt to issue. At $t = 2$, whether to repay it or not. The objective is to maximize the sum of generations 1 and 2 utility.

$$V(B, d) = AqB + U_1(C_1) + AqB + C_2$$

- B is the amount of debt issued in $t = 1$
- $d = 1$ indicates that debt is defaulted and $d = 0$ that debt is repaid
- A indicates the social return of public investment and is, more specifically, the utility generated by each unit of government borrowing and investment to each agent of every generation, which does not depend on the repayment decision and is assumed to be separable from the utility generated by consumption
- C_2 is the consumption of the represetative agent born in $t = 2$, who is risk neutral

Repayment Decision at $t = 2$

The government decides whether to repay or not at the beginning of period 2, after observing the random income shock received by generation 2 (y_2). It also takes into account how much debt was issued (B) and how much of it is in domestic hands (αy_1).

Social Welfare when the government repays is

$$V(d=0) = 2AqB + U_1 \left[\alpha \frac{y_1}{q} + (1-\alpha)\, y_1\right] + y_2 - B$$

where y_2 is output in period 2. Generation 2 receives as income the difference between output and taxes necessary to repay the government debt (B).

Social Welfare when the government defaults is

$$V(d=1) = 2AqB + U_1 \left[(1-\alpha)\, y_1\right] + (1-\lambda)\, y_2$$

Notice that, when default happens, generation 2 does not pay taxes but loses a fraction λ of its income.[5]

The government defaults for low realizations of income, when the output loss generated by this decision is less significant. Default happens when

$$y_2 < \frac{B + \left[U_1 \left[(1-\alpha)\, y_1\right] - U_1 \left[\alpha \frac{y_1}{q} + (1-\alpha)\, y_1\right]\right]}{\lambda} = y_2^c$$

Notice that there is an income region in which the taxes collected to repay the debt are higher than the output loss default would generate $(B > \lambda y_2)$ but the government still decides to repay so as not to hurt domestic creditors. If generation 1 agents were holding no government bonds $(\alpha = 0)$, the cut-off is given exactly by the point in which output loss and debt to be repaid are equal.

Repayment probability $p(\alpha)$

The ex-ante probability of repayment, for a distribution of the income shock $y_2 \sim F(y_2)$, is determined by the portfolio choice made in period 1.

$$p(\alpha, q) = 1 - F\left(y_2^c\right)$$

[5] In the real world, this can be a trade sanction or a decrease on FDI, which is more relevant when the economy is more productive.

$$p(\alpha, q) = 1 - F\left(\frac{B + \left[U_1\left[(1-\alpha)\, y_1\right] - U_1\left[\alpha\frac{y_1}{q} + (1-\alpha)\, y_1\right]\right]}{\lambda}\right)$$

Taking into account that $\frac{p}{q}(1-m) = 1$, the probability of repayment can be written as a function of only α $(p(\alpha))$.

Proposition 2 *The probability of repayment is increasing in α.*

$$\frac{dp}{d\alpha} > 0$$

Proof: see appendix (all proofs not in the text are in the appendix)

The decision not to repay the debt by the government generates a transfer from foreigners and generation 1 agents to generation 2 agents. The intuition of proposition 1 is that, when domestic agents born in period 1 hold a larger fraction of government debt in their portfolio, the transfer comes more from them (agents the government cares about) than from foreigners (agents the governments does not care about). Therefore, the government is less inclined to default.

Using the quadratic utility function and assuming a uniform distribution of income in $t = 2$, $y_2 \sim U\left[y_m, y^M\right]$, we can obtain two other properties of the probability function $p(\alpha)$ that will be useful afterwards.

Proposition 3 *The probability of repayment is bounded strictly between 0 and 1*

$$\begin{aligned} 0 &< p_m = p(\alpha = 0) \leq p(\alpha) \\ 1 &> p^M = p(\alpha = 1) \geq p(\alpha) \end{aligned}$$

Proposition 4 *The probability of repayment has a negative second order derivative with respect to α.*

$$\frac{d^2p}{d\alpha^2} \leq 0$$

Borrowing decision

At $t = 1$ the government decides how much debt B to issue. It will be assumed that there is a maximum sum $\bar{B}$ it is able to collect as taxes in $t = 2$. Therefore, the government cannot issue more than this level. At the beginning of $t = 2$ it still has the chance of not collecting the taxes and not repaying.

The government chooses B so as to maximize the expected welfare of the two generations, taking into account how its decision affects the i) portfolio choice of domestic agents (α), ii) the own government's future decision of when to default (y_2^c), iii) the probability of repayment p and iv) the price of the bond q.

$$\max_{B \leq \bar{B}} AqB + E\left[U_1(\alpha)\right] + AqB + E\left[C_2\right]$$

For a high enough rate of return of public investment A, which will be assumed in the model, the government chooses to borrow as much as possible. The level $\bar{B}$ is assumed to be such that the amount borrowed (qB) still increases by issuing more debt (B). That is, that the reduction in the price caused by higher debt does not completely offset the quantity effect (see explicit expression in the appendix).

Proposition 5 *The government issues debt up to the maximum possible level $B = \bar{B}$.*

2.3.5 Portfolio Choice $\alpha(p)$

A financial institution chooses which share of the savings received to invest in government bonds, so as to maximize the domestic agent's expected utility. The share is bounded between 0 and 1.

$$\max_{0 \leq \alpha \leq 1} E(U_1) = ay_1\left(\alpha\frac{m}{1-m} + 1\right) - by_1^2\left[\alpha^2\frac{(1-p)}{p(1-m)^2}\right] - by_1^2\left[\alpha\frac{m}{1-m} + 1\right]^2$$

The financial institutions takes into account not only the direct effect of α in expected utility, but also the effect that a change in α has on the probability of repayment. As each financial institution holds a share c of total savings, the marginal impact of its choice on repayment probability is $c\frac{dp}{d\alpha}$. The first order condition is then

$$\begin{aligned}\frac{\partial E(U_1)}{\partial \alpha} &= ay_1\frac{m}{1-m} - 2by_1^2\alpha\frac{(1-p)}{p(1-m)^2} - 2by_1^2\left[\alpha\frac{m}{1-m}+1\right]\frac{m}{1-m} \\ &+\frac{by_1^2\alpha^2}{p^2\left(1-m\right)^2}c\frac{dp}{d\alpha}\end{aligned}$$

When there is an infinite number of financial institutions and the investment decisions are completely dispersed ($c \approx 0$), the portfolio choice[6] is

$$\alpha(c \approx 0) = \frac{m\left(1-m\right)\left(a-2by_1\right)}{2by_1\left(\frac{1-p}{p}+m^2\right)}$$

As $\frac{dp}{d\alpha} > 0$, the fourth term in the first order condition is positive. Therefore, as the second order derivative is negative (shown in the appendix), the demand for government bonds is higher when there is a significant degree of financial concentration.

Proposition 6 *The demand of government bonds by domestic agents is increasing in the degree of financial concentration (c).*

$$\frac{d\alpha}{dc} > 0$$

The fact that the behavior of the government is influenced by domestic bondholdings creates an externality in the investment choice: a larger demand for bonds by a domestic financial institution generates a higher probability of repayment for every bondholder. The degree to which the externality is internalized by the domestic financial institution is given by its share in domestic savings (c). When financial decisions are concentrated (c is high) and the institution has more influence over the total α, the possibility to improve the behavior of the government by investing a larger share in bonds is higher and so is the incentive to do it.

2.3.6 Equilibrium

An equilibrium is given by

[6]With the appropriate assumptions on parameters so as to have an interior solution.

1. an amount of debt B^* issued by the government
2. a fraction of income invested in government bonds α^* by domestic agents
3. a probability of repayment p^*
4. a price of the government bond q^*

Such that

1. the government maximizes expected welfare at $t = 1$
2. financial institutions maximize agents' expected utility: $\alpha^* = \alpha(p^*)$
3. the decision of the government to maximize welfare at $t = 2$ generates a probability of repayment $p^* = p(\alpha^*)$
4. the no-arbitrage condition for foreign investors $\frac{p^*}{q^*}(1 - m) = 1$

Proposition 7 *Existence: there exist a stable equilibrium $(\alpha^*, p^*, q^*, B^*)$ such that conditions above are satisfied. (proof in the appendix)*

2.4 Alleviating the Commitment Problem

The main point of this paper is that (although it might have other drawbacks) concentration in the domestic financial market is helpful to put discipline on the government, reduce the chances of debt repudiation an increase its borrowing capacity. Institutions acting on behalf of larger numbers of small domestic investors realize, at the time of making their portfolio choice, that by increasing their holdings of government bonds they give higher incentives to repay to the government. The larger the number of domestic agents the institution represents, the bigger its (political) power to influence the behavior of the government and the higher the share of government bonds in its portfolio. Therefore, concentration in less and bigger institutions leads to a higher domestic demand for government bonds, a higher chance of repayment and a lower interest rate.

A way of reducing the participation of foreign investors in government bondholdings and inducing a more friendly behavior towards all investors is, as stated in Tirole (2003), to impose restrictions on international capital flows. In the present model, I associate the size of the restrictions to international capital flows to the fraction of capital loss by foreigners when they transfer resources out of the country (m). I find that an increase in m generates a higer chance of repayment, as financial concentration, but does not necessarily lead to higher bond prices. This is because the increase in m reduces the foreign demand for government bonds, which might more than compensate the effect of the higher repayment probability and might, therefore, actually decrease the borrowing capacity of the government.

2.4.1 Financial Concentration

The fact that financial concentration alleviates the commitment problem of the government was not, as far as I know, mentioned in the previous literature. Financial concentration creates a greater coordination in the investment decision by the agents, increasing the degree in which they internalize their influence in the government's behavior. Their demand for government bonds is, therefore, higher, which reduces the incentive of the government to default, increases the probability of repayment and also increases the price of the bonds.

In this model, a higher degree of financial concentration can be represented by an increase in the parameter c. This increases the overall demand for bonds by domestic agents ($\frac{d\alpha}{dc} > 0$), the probability of repayment ($\frac{dp}{d\alpha} > 0 \implies \frac{dp}{dc} > 0$) and price of government bonds ($\frac{dq}{dp} > 0 \implies \frac{dq}{dc} > 0$).

Proposition 8 *An increase in the share of agents that coordinate their investment decision (c), increases the probability of repayment and the price of government bonds. (proof in the appendix)*

2.4.2 Capital Controls

I present a context of atomistic financial decisions where the policy the government can follow to reduce its commitment problem is to restrict foreign capital flows, which in this model would be raising m. This policy has 2 effects: i) it increases the expected return of the domestic bond for domestic residents but ii) it also increases its volatility. In Tirole (2003), where all agents were risk averse, this would unambiguously increase domestic bondholdings by local citizens.

However, when foreign agents are risk neutral and domestic agents are risk averse, the overall effect over domestic bondholdings is ambiguous. We can make sure that the higher expected returns predominates and bondholdings by domestic agents increase, as in Tirole (2003), by imposing an upperbound restriction on m.

Proposition 9 *If $m < m^*$, $\frac{\partial \alpha}{\partial m} > 0$ the effect of the increase in the expected return predominates and an increase in m increases the desired bond holdings by domestic agents.*

As shown before, the increase in α leads to an increase in the probability of repayent But, even though the increase in the cost of capital outflows unambiguously increases the probability of repayment (p), the effect on the price of the bond (q) is unclear. From the point of view of the foreigners, the increase in the chance of being repaid might not be enough to compensate the loss due to the higher m, and a drop in the price (increase in the interest rate) might be required to have foreigners demanding bonds. This would reduce the borrowing capacity of the government.

$$\frac{\partial q}{\partial m} = -p + (1-m)\frac{\partial p}{\partial m} \lesseqgtr 0$$

Proposition 10 *The increase in the restrictions on foreign capital flows increases the probability of repayment by the government but has an ambiguous effect on the price of bonds.*

2.5 Conclusions

This paper analyzes the role that the domestic financial structure of a country plays in determining the cost of credit for the government and its borrowing capacity. The model is based on the fact that governments favor domestic interests over foreign ones, that this creates an externality and that degree to which this externality is taken into account by domestic agents depends on the framework in which their financial decisions are made.

In the particular case of government debt that is held both by domestic and foreign agents, the government is more reluctant to default if there are more domestic agents among those hurt by the decision. Therefore, when they demand more debt, domestic agents increase the probability of repayment and improve the quality of government bonds for all bondholders.

Small agents do not internalize this effect and demand less government debt than what is optimal from the aggregate point of view. On the other hand, if domestic agents act in a more coordinated way, by delegating their investment decisions in bigger financial institution for example, they internalize the effect and demand more bonds than what they would demand if acting on their own. This reduces the probability of default of public debt and the cost of credit for the government.

An institutional organization that creates this type of coordination would be a private social security system in which workers' saving are administered by a reduced number of companies, as happens in several latinamerican countries. It is observed, in these cases, that private pension funds have a strong bias towards government bonds in their investment decision, even if the regulation does not require them to hold this kind of assets. This is coherent with the theory developed in this paper.

The imposition of restrictions on international capital flows is another way of increasing the share of domestic agents among those holding government debt and of, therefore, increasing the probability of repayment. But this comes at the cost of reducing foreign supply of credit and does not necessarily lead to a lower cost of borrowing for the government.

Finally, this paper has implications for the home bias debate. The existence of large financial institutions that concentrate the decisions of several domestic investors increases the demand for government bonds and can be an additional factor explaining why the demand for domestic assets is greater than what would seem optimal from a pure risk diversification approach.

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2.6 Appendix

2.6.1 Proof of Proposition 1

The function $p(\alpha, q)$ has the following partial derivatives

$$
\begin{aligned}
p(\alpha, q) &= 1 - F(y_c) \\
p(\alpha, q) &= 1 - F\left(\frac{B + U((1-\alpha)y_1) - U\left(\frac{\alpha y_1}{q} + (1-\alpha)y_1\right)}{\lambda}\right) \\
p'_\alpha &= -f()\frac{-U'((1-\alpha)y_1)y_1 - U'\left(\frac{\alpha y_1}{q} + (1-\alpha)y_1\right)\left(\frac{1-q}{q}\right)y_1}{\lambda} > 0 \\
p'_q &= -f()\frac{-U'\left(\frac{\alpha y_1}{q} + (1-\alpha)y_1\right)\left(-\frac{\alpha}{q^2}\right)y_1}{\lambda} < 0
\end{aligned}
$$

Use the no arbitrage condition to get the total derivative.

$$
\begin{aligned}
\frac{p}{q} &= \frac{1}{1-m} \Longrightarrow \frac{dq}{d\alpha} = (1-m)\frac{dp}{d\alpha} \\
\frac{dp}{d\alpha} &= p'_\alpha + p'_q\frac{dq}{d\alpha} \\
\frac{dp}{d\alpha} &= p'_\alpha + p'_q(1-m)\frac{dp}{d\alpha} \\
\frac{dp}{d\alpha} &= \frac{p'_\alpha}{1 - p'_q(1-m)} > 0
\end{aligned}
$$

2.6.2 Proof of Proposition 2

$$
\begin{aligned}
p(\alpha,q) &= \frac{y^M - y_c}{y^M - y_m} \\
p(\alpha,q) &= \frac{y^M}{y^M - y_m} - \frac{B}{\lambda\left(y^M - y_m\right)} \\
&\quad + \frac{\left[a\left(\frac{\alpha y_1}{q} + (1-\alpha) y_1\right) - b\left(\frac{\alpha y_1}{q} + (1-\alpha) y_1\right)^2 - a(1-\alpha) y_1 + b\left((1-\alpha) y_1\right)^2\right]}{\lambda\left(y^M - y_m\right)} \\
p(\alpha,q) &= \frac{\lambda y^M - B}{\lambda\left(y^M - y_m\right)} + \frac{a\left(\frac{\alpha y_1}{q}\right) - b\left(\frac{\alpha^2 y_1^2}{q^2} + \frac{\left(\alpha - \alpha^2\right) y_1^2}{q}\right)}{\lambda\left(y^M - y_m\right)}
\end{aligned}
$$

$$
\begin{aligned}
p_m &= p(\alpha = 0, q) = \frac{\lambda y^M - B}{\lambda\left(y^M - y_m\right)} \\
p^M &= p(\alpha = 1, q) = \frac{\lambda y^M - B}{\lambda\left(y^M - y_m\right)} + \frac{a\left(\frac{y_1}{q}\right) - b\left(\frac{y_1}{q}\right)^2}{\lambda\left(y^M - y_m\right)} \\
p^M &= \frac{\lambda y^M - B}{\lambda\left(y^M - y_m\right)} + \frac{1}{\lambda\left(y^M - y_m\right)}\left[a\left(\frac{y_1}{(1-m)\, p^M}\right) - b\left(\frac{y_1}{(1-m)\, p^M}\right)^2\right] \\
B\left(p^M\right) &= \lambda y^M + a\left(\frac{y_1}{(1-m)\, p^M}\right) - b\left(\frac{y_1}{(1-m)\, p^M}\right)^2 - p^M \lambda\left(y^M - y_m\right)
\end{aligned}
$$

The last expression gives the amount of debt necessary to generate a maximum repayment probability p^M. It is decreasing in p^M (marginal utility is positive). It is assumed that the maximum level that the government is able to issue is lower than λy^M (so as to have strictly positive repayment probability for any α) and higher than $B\left(p^M = 1\right)$.

2.6.3 Proof of Proposition 3

For the specified functional forms, first order partial derivatives are

$$
\begin{aligned}
p(\alpha, q) &= \frac{\lambda y^M - B}{\lambda (y^M - y_m)} + \frac{1}{\lambda (y^M - y_m)} \left[\frac{a\alpha y_1}{q} - b y_1^2 \left(\left(\frac{\alpha}{q} \right)^2 + \frac{2\alpha (1-\alpha)}{q} \right) \right] \\
p'_\alpha &= \frac{1}{\lambda (y^M - y_m)} \left[\frac{a y_1}{q} - b y_1^2 \left(\frac{2\alpha}{q^2} + \frac{2(1-2\alpha)}{q} \right) \right] > 0 \\
p'_q &= \frac{1}{\lambda (y^M - y_m)} \left[-\frac{a\alpha y_1}{q^2} + b y_1^2 \left(\frac{2\alpha^2}{q^3} + \frac{2\alpha (1-\alpha)}{q^2} \right) \right] \\
p'_q &= -\frac{\alpha}{q} p'_\alpha
\end{aligned}
$$

...and first order total derivatives are

$$
\begin{aligned}
\frac{dp}{d\alpha} &= p'_\alpha + p'_q \frac{dq}{d\alpha} \\
\frac{dp}{d\alpha} &= p'_\alpha - \frac{\alpha}{q} p'_\alpha (1-m) \frac{dp}{d\alpha} \\
\frac{dp}{d\alpha} &= \frac{p'_\alpha}{1 + \frac{\alpha}{q} p'_\alpha (1-m)} > 0 \\
\frac{dq}{d\alpha} &= \frac{p'_\alpha (1-m)}{1 + \frac{\alpha}{q} p'_\alpha (1-m)} > 0
\end{aligned}
$$

Second Order Total Derivative

$$
\frac{d^2 p}{d\alpha^2} = -\left(\frac{dp}{d\alpha} \right)^2 \left[\begin{array}{c} \frac{1-m}{q} - \frac{\alpha(1-m)}{q^2} \frac{dq}{d\alpha} \\ -\frac{\lambda\left(y^M - y_m\right)\left[-2by_1^2\left(\frac{1}{q^2} - \frac{2}{q}\right) + \frac{dq}{d\alpha}\left(-\frac{ay_1}{q^2} - 2by_1^2\left(-\frac{2\alpha}{q^3} - \frac{(1-2\alpha)}{q^2}\right)\right)\right]}{\left[\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)(1-m)\right]^2} \end{array} \right]
$$

$$
\frac{d^2 p}{d\alpha^2} = -\left(\frac{dp}{d\alpha} \right)^2 \left[\begin{array}{c} \frac{1-m}{q} - \frac{\alpha(1-m)}{q^2} \frac{1}{\frac{\lambda\left(y^M - y_m\right)}{\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)(1-m)} + \frac{\alpha}{q}} \\ -\frac{\lambda\left(y^M - y_m\right)\left[-2by_1^2\left(\frac{1}{q^2} - \frac{2}{q}\right) + \frac{dq}{d\alpha}\left(-\frac{ay_1}{q^2} - 2by_1^2\left(-\frac{2\alpha}{q^3} - \frac{(1-2\alpha)}{q^2}\right)\right)\right]}{\left[\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)(1-m)\right]^2} \end{array} \right]
$$

$$
\begin{aligned}
\frac{d^2p}{d\alpha^2} &= -\left(\frac{dp}{d\alpha}\right)^2 \left[\frac{\frac{1-m}{q} - \frac{1}{\frac{\lambda\left(y^M - y_m\right)q^2}{\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)\alpha(1-m)^2} + \frac{q}{1-m}}}{} - \frac{\lambda\left(y^M - y_m\right)\left[-2by_1^2\left(\frac{1}{q^2} - \frac{2}{q}\right) + \frac{dq}{d\alpha}\left(-\frac{ay_1}{q^2} - 2by_1^2\left(-\frac{2\alpha}{q^3} - \frac{(1-2\alpha)}{q^2}\right)\right)\right]}{\left[\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)(1-m)\right]^2} \right] \\
\frac{d^2p}{d\alpha^2} &= -\left(\frac{dp}{d\alpha}\right)^2 \left[\frac{\frac{\lambda\left(y^M - y_m\right)q}{\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)\alpha(1-m)}}{\frac{\lambda\left(y^M - y_m\right)q^2}{\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)\alpha(1-m)^2} + \frac{q}{1-m}} - \frac{\lambda\left(y^M - y_m\right)\left[-2by_1^2\left(\frac{1}{q^2} - \frac{2}{q}\right) + \frac{dq}{d\alpha}\left(-\frac{ay_1}{q^2} - 2by_1^2\left(-\frac{2\alpha}{q^3} - \frac{(1-2\alpha)}{q^2}\right)\right)\right]}{\left[\frac{ay_1}{q} - 2by_1^2\left(\frac{\alpha}{q^2} + \frac{(1-2\alpha)}{q}\right)(1-m)\right]^2} \right]
\end{aligned}
$$

The first term in the bracket is positive. I look now for sufficient conditions to make the second term also positive and obtain the negative derivative. If $q < p^M\,(1-m) < \frac{1}{2}$, it is then sufficient to have

$$
\begin{aligned}
-\frac{ay_1}{q^2} - 2by_1^2\left(-\frac{2\alpha}{q^3} - \frac{(1-2\alpha)}{q^2}\right) &< 0 \\
-a + \frac{4\alpha b y_1}{q} + (1-2\alpha)\,2by_1 &< 0 \\
2 + 4\alpha\frac{1-q}{q} &< \frac{a}{by_1} \\
q &> \frac{4by_1}{a+2by_1} \\
p_m\,(1-m) &> \frac{4by_1}{a+2by_1}
\end{aligned}
$$

The assumption $q < \frac{1}{2}$ is required so as to guarantee a positive marginal utility of consumption in the repayment state when $\alpha = 1$ ($\frac{a}{by_1} > 1$, assumed in the utility function, does not guarantee this positive marginal utility).

$$
\begin{aligned}
\frac{\partial U\left(\alpha=1\right)}{\partial C} &= a-2b\left(\frac{y_1}{q}\right)>0 \\
&\Longleftrightarrow \\
\frac{a}{by_1} &> \frac{2}{q} \\
\frac{1}{2} &> q
\end{aligned}
$$

2.6.4 Proof of Proposition 4

This proof shows that, under some conditions, the derivative of welfare with respect to B is positive for both generations. Therefore, the government goes for maximum borrowing $\bar{B}$. The conditions are that the public investment is productive enough and that debt is not too high ($\bar{B} < \hat{B}$), so as that the amount borrowed (qB) increases with the amount of debt issued (B).

Generation 1

$$
\begin{aligned}
E(W_1) &= ABq + E(U_1) \\
\frac{dE(W_1)}{dB} &= A(1-m)p + AB(1-m)\frac{\partial p}{\partial B} + \frac{\partial E(U_1)}{\partial \alpha}\frac{\partial \alpha}{\partial p}\frac{dp}{dB} + \frac{\partial E(U_1)}{\partial p}\frac{dp}{dB} \\
\frac{dE(U_1)}{d\alpha} &= 0 \Longrightarrow \\
\frac{dE(W_1)}{dB} &= A(1-m)p + AB(1-m)\frac{dp}{dB} + \frac{\partial E(U_1)}{\partial p}\frac{dp}{dB}
\end{aligned}
$$

Given that $E(U_1) = ay_1\left(\alpha\frac{m}{1-m}+1\right) - by_1^2\left[\alpha^2\frac{(1-p)}{p(1-m)^2}\right] - by_1^2\left[\alpha\frac{m}{1-m}+1\right]^2$

$$
\frac{dE(W_1)}{dB} = A(1-m)p + AB(1-m)\frac{dp}{dB} + by_1^2\frac{dp}{dB}\left[\left(\frac{\alpha}{(1-m)p}\right)^2\right]
$$

Using the probability function

$$
\begin{aligned}
p(\alpha,q) &= \frac{\lambda y^M - B}{\lambda(y^M - y_m)} + \frac{1}{\lambda(y^M - y_m)}\left[\frac{a\alpha y_1}{q} - by_1^2\left(\left(\frac{\alpha}{q}\right)^2 + \frac{2\alpha(1-\alpha)}{q}\right)\right] \\
p'_\alpha &= \frac{1}{\lambda(y^M - y_m)}\left[\frac{ay_1}{q} - by_1^2\left(\frac{2\alpha}{q^2} + \frac{2(1-2\alpha)}{q}\right)\right] \\
p'_q &= -\frac{\alpha}{q}p'_\alpha \\
\frac{dp}{dB} &= \frac{-1}{\lambda(y^M - y_m)} + \frac{1}{\lambda(y^M - y_m)}p'_\alpha\frac{\partial \alpha}{\partial p}\frac{dp}{dB} + \frac{1}{\lambda(y^M - y_m)}p'_q\frac{dq}{dB} \\
\frac{dp}{dB} &= \frac{-1}{\lambda(y^M - y_m) - p'_\alpha\left(\frac{\partial \alpha}{\partial p} - \frac{\alpha}{p}\right)} > \frac{-1}{\lambda(y^M - y_m) + p'_\alpha\frac{\alpha}{p}}
\end{aligned}
$$

$$\frac{dE(W_1)}{dB} > A(1-m)p - \frac{AB(1-m) + by_1^2\left(\frac{\alpha}{(1-m)p}\right)^2}{\lambda\left(y^M - y_m\right) + \left[\frac{ay_1\alpha}{p^2(1-m)} - by_1^2\left(\frac{2\alpha^2}{p^3(1-m)^2} + \frac{2(\alpha-2\alpha^2)}{p^2(1-m)}\right)\right]}$$

A sufficient condition to have $\frac{dE(W_1)}{dB} > 0$

$$\begin{aligned}
A(1-m)p - \frac{AB(1-m) + by_1^2\left(\frac{\alpha}{(1-m)p}\right)^2}{\lambda\left(y^M - y_m\right) + \left[\frac{ay_1\alpha}{p^2(1-m)} - by_1^2\left(\frac{2\alpha^2}{p^3(1-m)^2} + \frac{2(\alpha-2\alpha^2)}{p^2(1-m)}\right)\right]} &> 0 \\
A(1-m)p\left[\begin{array}{c} \lambda\left(y^M - y_m\right) \\ +\left[\frac{ay_1\alpha}{p^2(1-m)} - by_1^2\left(\frac{2\alpha^2}{p^3(1-m)^2} + \frac{2(\alpha-2\alpha^2)}{p^2(1-m)}\right)\right] \end{array}\right] &> AB(1-m) \\
&\quad +by_1^2\left(\frac{\alpha}{(1-m)p}\right)^2 \\
A\left[\begin{array}{c} \lambda\left(y^M - y_m\right)p(1-m) \\ +\frac{\alpha}{p}y_1\left[a - 2by_1\left(\frac{\alpha}{p(1-m)} + (1-2\alpha)\right)\right] - B(1-m) \end{array}\right] &> \frac{\alpha^2 by_1^2}{(1-m)^2 p^2}
\end{aligned}$$

As $a - 2by_1\left(\frac{\alpha}{p(1-m)} + (1-2\alpha)\right) > 0$, a sufficient condition is

$$A > \frac{\frac{\alpha^2 by_1^2}{(1-m)^2 p^2}}{\lambda\left(y^M - y_m\right)p(1-m) - B(1-m)}$$

Define

$$A_{\min} = \frac{by_1^2}{\lambda\left(y^M - y_m\right)p_m^3(1-m)^3 - \bar{B}p_m^2(1-m)^3}$$

$\bar{B} < 2\lambda y^M$ guarantees that the denominator is positive.

$$A > A_{\min} \implies \frac{dE(W_1)}{dB}$$

Generation 2

The expected welfare for generation 2 is

$$
\begin{aligned}
E(W_2) &= ABq + \int_{y_m}^{y_2^c} (1-\lambda)\, y_2 f(y_2)\, dy_2 + \int_{y_2^c}^{y^M} (y_2 - B) f(y_2)\, dy_2 \\
E(W_2) &= ABp(1-m) + \frac{y^M + y_m}{2} - \lambda \frac{(y_2^c)^2 - y_m^2}{2} - Bp \\
E(W_2) &= ABp(1-m) + \frac{y^M + y_m}{2} - \lambda \frac{(y_M(1-p) + py_m)^2 - y_m^2}{2} - Bp
\end{aligned}
$$

As $\frac{dp}{dB} > 0$, a sufficient condition to have $\frac{dE(W_2)}{dB} > 0$ is...

$$
\begin{aligned}
\frac{d[A(1-m) - 1]\, pB}{dB} &\geq 0 \\
\frac{dpB}{dB} &\geq 0
\end{aligned}
$$

that the amount borrowed (qB) increases with the debt issued (B).

$$
\begin{aligned}
\frac{-1}{\lambda\left(y^M - y_m\right) + \left[\frac{ay_1\alpha}{p^2(1-m)} - by_1^2\left(\frac{2\alpha^2}{p^3(1-m)^2} + \frac{2(\alpha-2\alpha^2)}{p^2(1-m)}\right)\right]} &< \frac{dp}{dB} \\
p - \frac{B}{\lambda\left(y^M - y_m\right) + \left[\frac{ay_1\alpha}{p^2(1-m)} - by_1^2\left(\frac{2\alpha^2}{p^3(1-m)^2} + \frac{2(\alpha-2\alpha^2)}{p^2(1-m)}\right)\right]} &> 0 \\
p\lambda\left(y^M - y_m\right) + \left[\frac{ay_1\alpha}{p(1-m)} - by_1^2\left(\frac{2\alpha^2}{p(1-m)^2} + \frac{2\left(\alpha - 2\alpha^2\right)}{p(1-m)}\right)\right] &> B \\
p_m\lambda\left(y^M - y_m\right) &> B
\end{aligned}
$$

The sufficient condition is

$$
\bar{B} < B^M = p_m\lambda\left(y^M - y_m\right) \implies \frac{dE(W_2)}{dB} > 0
$$

2.6.5 Proof of Proposition 5

First, we show that $\frac{\partial^2 E(U_c)}{\partial\alpha^2} < 0$. Given that $\frac{\partial^2 p}{\partial\alpha^2} \leq 0$, it is sufficient to show

$$
\begin{aligned}
-2by_1^2\frac{(1-p)}{p(1-m)^2}-2by_1^2\frac{m}{1-m}+\frac{4by_1^2\alpha}{p^2(1-m)^2}\frac{dp}{d\alpha}c-\frac{2by_1^2\alpha^2}{p^3(1-m)^2}\left(\frac{dp}{d\alpha}\right)^2c^2 &< 0\\
-\frac{(1-p)}{p(1-m)}-m+\frac{2\alpha}{p^2(1-m)}\frac{dp}{d\alpha}c-\frac{\alpha^2}{p^3(1-m)}\left(\frac{dp}{d\alpha}\right)^2c^2 &< 0\\
\frac{(1-p)}{p(1-m)}+m+\frac{\alpha^2}{p^3(1-m)}\left(\frac{dp}{d\alpha}\right)^2c^2 &> \frac{2\alpha}{p^2(1-m)}\frac{dp}{d\alpha}c\\
p(1-p)+p^2m(1-m)+\frac{\alpha^2}{p}\left(\frac{dp}{d\alpha}\right)^2c^2 &> 2\alpha\frac{dp}{d\alpha}c\\
\frac{(1-p)}{\frac{\alpha}{p}\frac{dp}{d\alpha}c}+\frac{pm(1-m)}{\frac{\alpha}{p}\frac{dp}{d\alpha}c}+\frac{\alpha}{p}\frac{dp}{d\alpha}c &> 2
\end{aligned}
$$

Using the expressions for $\frac{dp}{d\alpha}$ obtained before

$$
\begin{aligned}
\frac{dp}{d\alpha} &= \frac{p'_\alpha}{1+\frac{\alpha}{p}p'_\alpha}\\
\frac{\alpha}{p}\frac{dp}{d\alpha}c &= \frac{\frac{\alpha}{p}p'_\alpha c}{1+\frac{\alpha}{p}p'_\alpha}=\frac{c}{\frac{p}{\alpha p'_\alpha}+1}=\frac{c\alpha p'_\alpha}{p+\alpha p'_\alpha}\\
p'_\alpha &= \frac{1}{\lambda\left(y^M-y_m\right)}\left[\frac{ay_1}{q}-by_1^2\left(\frac{2\alpha}{q^2}+\frac{2(1-2\alpha)}{q}\right)\right]
\end{aligned}
$$

The sufficient condition is

$$
\begin{aligned}
\frac{(1-p)}{\frac{\alpha}{p}\frac{dp}{d\alpha}c}+\frac{pm(1-m)}{\frac{\alpha}{p}\frac{dp}{d\alpha}c}+\frac{\alpha}{p}\frac{dp}{d\alpha}c &> 2\\
\frac{(1-p)\left(p+\alpha p'_\alpha\right)}{c\alpha p'_\alpha}+\frac{pm(1-m)\left(p+\alpha p'_\alpha\right)}{c\alpha p'_\alpha}+\frac{c\alpha p'_\alpha}{p+\alpha p'_\alpha} &> 2\\
\frac{(1-p)+pm(1-m)}{c}+\frac{p(1-p)+p^2m(1-m)}{c\alpha p'_\alpha}+\frac{c\alpha p'_\alpha}{p+\alpha p'_\alpha} &> 2
\end{aligned}
$$

Focusing just on the first term

$$
\frac{(1-p)+pm(1-m)}{c}>2 \iff p<\frac{1-2c}{1-m(1-m)}
$$

A sufficient condition is

$$c < \bar{c} = \frac{1 - p^{MAX}\left[1 - m\left(1 - m\right)\right]}{2}$$

Now, looking at the FOC

$$\frac{\partial E(U)}{\partial \alpha} = ay_1 \frac{m}{1-m} - 2by_1^2 \alpha \frac{(1-p)}{p(1-m)^2} - 2by_1^2 \left[\alpha \frac{m}{1-m} + 1\right] \frac{m}{1-m} + \frac{by_1^2 \alpha^2}{p^2 \left(1-m\right)^2} \frac{dp}{d\alpha} c$$

we see that the fourth term is increasing in c. Therefore, the choice of α is increasing in c.

2.6.6 Proof of Proposition 6: Existence

B^* was already found to be the maximum possible level of debt issued by the government and finding q^* is straightforward after having p^*

We know that $p(\alpha)$ is increasing $(\frac{dp(\alpha)}{d\alpha})$, continuous and bounded strictly between 0 and 1 $(0 < p(\alpha) < 1)$ We also know that $\alpha(p)$ is increasing $(\frac{d\alpha(p)}{dp})$, continuous, that $\alpha(p = 0) \geq 0$ and that $\alpha(p = 1) = 1$. Therefore, it exists p^* $(0 < p^* < 1)$ and α^* $(0 \leq \alpha^* \leq 1)$ such that $p^* = p(\alpha^*)$ and $\alpha^* = \alpha(p^*)$

2.6.7 Proof of Proposition 7

We have $\alpha(m)$ from the uncoordinated domestic agent's problem solved above.

$$\begin{aligned}
\max_{\alpha} E(U_1) &= p\left[a\left(\frac{\alpha}{q}+(1-\alpha)\right)y_1 - b\left(\frac{\alpha}{q}+(1-\alpha)\right)^2 y_1^2\right] \\
&\quad +(1-p)\left[a(1-\alpha)y_1 - b(1-\alpha)^2 y_1^2\right]
\end{aligned}$$

$$\alpha = \frac{(a-2by_1)\,m(1-m)}{2by_1\left(\frac{1}{p}-1+m^2\right)}$$

Finding $\frac{\partial\alpha}{\partial m}$

$$\frac{\partial\alpha}{\partial m} = \frac{(a-2by_1)(1-2m)}{2by_1\left(\frac{1}{p}-1+m^2\right)} - \frac{(a-2by_1)\,m(1-m)}{2by_1\left(\frac{1}{p}-1+m^2\right)^2}2m$$

Sign of $\frac{\partial\alpha}{\partial m}$

$$\frac{\partial\alpha}{\partial m} > 0 \iff \frac{(a-2by_1)(1-2m)}{4mby_1} > \frac{(a-2by_1)\,m(1-m)}{2by_1\left(\frac{1}{p}-1+m^2\right)} = \alpha < 1$$

Impose a sufficient condition on m to finish the proof

$$\begin{aligned}
\text{if } \frac{(a-2by_1)(1-2m)}{4bmy_1} &> 1 \implies \frac{\partial\alpha}{\partial m} > 0 \\
\text{if } \frac{1}{2m} - 1 &> \frac{2by_1}{(a-2by_1)}1 \implies \frac{\partial\alpha}{\partial m} > 0 \\
\text{if } \frac{1}{2m} &> \frac{a}{a-2by_1} \implies \frac{\partial\alpha}{\partial m} > 0 \\
\text{if } m &< \frac{a-2by_1}{2a} = m^* \implies \frac{\partial\alpha}{\partial m} > 0
\end{aligned}$$

Chapter 3

Sovereign Defaults and Firms' Foreign Credit: The Banking System Channel

3.1 Introduction

It has been documented that sovereign and private default risks move together. Arellano and Kocherlakota (2007), for example, find that EMBI+ spreads and interest rates paid by the domestic private sector are positively and strongly correlated in 15 out of 18 countries for which they find data, with correlations of 0.85 and 0.81 for Mexico and Argentina, respectively. It is also observed that domestic banks were significantly exposed to sovereign risk in the emerging economies that have experienced default episodes and that both residents and non-residents were affected by sovereign debt restructurings. Data for six recent cases is presented below (Russia 1998, Ukraine 1998, Ecuador 1999, Pakistan 1999, Argentina 2001 and Uruguay 2003). These are cases for which good information about the size of the debt reductions and the way different agents were treated can be found.

The following table shows how claims on central government accounted for an important size ok banks' deposits just before public debt was restructured. We can see the average exposure for the immediate month, quarter, semester and year before the start of the default episode, and find that this exposure was very important. For the countries that applied larger haircuts, which were Argentina and Russia, this exposure was more than 25% and almost 66% respectively.

Banks' Claims on Government as % of Deposits

Average in	Russia	Ukraine	Pakistan	Ecuador	Argentina	Uruguay
1 month	62.1%	33.0%	36.7%	26.2%	28.2%	10.8%
3 months	66.1%	30.4%	38.5%	34.3%	26.3%	15.9%
6 months	65.1%	31.3%	38.1%	31.5%	27.2%	15.0%
12 months	64.5%	31.5%	39.0%	24.7%	26.4%	14.1%

Source: International Financial Statistics, IMF

Sturzenegger and Zettelmeyer (2005), in a detailed study of these six cases of sovereign debt restructurings, find there was no significant difference in treatment for residents and non-residents. Ecuador and Pakistan only restructured international bonds, but the other countries restructured domestically issued ones as well. Argentina applied approximate cuts of 70% for domestic investors and 73% for international ones. Uruguay, of 23% for domestic and 13% for international. Russia restructured i) domestically issued and domestic currency denominated bonds (45% on residents and 61% on nonresidents), ii) domestically issued and foreign currency denominated bonds (63%) and iii) externally issued and foreign currency denominated bonds (53%). Finally, Ukraine restructured international bonds (28%) and domestic bonds (7% for residents and 56% for nonresidents, although the second ones received Eurobonds and the first ones domestic currency instruments subject to capital controls).

The sovereign debt literature has mostly focused on the question of why government repay their foreign debts. The question arises because the legal enforceability of sovereign debt contracts is very weak: sovereign governments cannot be affected by bankruptcy procedures and they don't have many assets that could be seized by foreign creditors. The immediate consequence of these doubts about why governments repay is the appearence of a question of why foreigners are willing to lend them.

Eaton and Gersovitz (1981), in the founding paper of this literature, propose the exclusion from foreign credit markets that follows a default episode and the resulting inability to smooth consumption in the future by the defaulting country as a central explanation of why governments repay. The paper is, therefore, in the group that explores a reputation explanation. Bulow and Rogoff (1989a), in a critique to explanations of this kind, showed that, if countries have access to a rich enough set of assets after non-repayment, the exclusion from financial markets, due to the bad name created after default, cannot be the explanation for repayment. There is always a point in time from where on net repayments to foreigners would be positive and, therefore, at which the government would find optimal to repudiate its debt and start saving to replicate the original contract's payments, with the benefit of an additional income. They suggested direct sanctions as an alternative explanation.

The eventual trade sanctions that would arise after a default episode were a natural candidate to explain repayment, but this explanation was not supported by the evidence. Martínez and Sandleris (2003), for example, show that the decline of foreign trade that follows a default episode is not different with creditor countries than with the rest of countries that were not affected by the non'repayment decision. This gave rise to a number of papers that intend to revive the reputation (credit market exclusion) explanation. A restriction in the set of saving technologies available to the country can arise, for example, if banks are unable to commit to repay (Kletzer and Right 2000) or if they can collude with each other (Wright 2002). Alternatively, countries might be myopic and not able to save optimally if different parties alternate in power (Amador 2003), which makes them willing to repay and continue having access to foreign borrowing so as to smooth consumption.

The papers mentioned above did not make explicit that there are different kind of creditors borrowing from abroad in a given country, the government on one side and private agents on the other. There are other papers that make this distinction, and show that the decision to default by the government might negatively affect the situation of the other borrowers and their access to foreign credit markets. Sandleris (2005), for example, incorporates an information revelation mechanism in which a government that defaults reveals private information about the economy's fundamentals that makes financial investors pessimistic about the firms' future performance and reduces their ability to borrow from abroad. In other kind of models, with Cole and Kehoe (1997) as an example, governments who default reveal themselves as being of a "bad type" and difficult other economic relations for itself or for the whole country, one of which is foreign borrowing by private agents. In the present paper I also make the distinction between the government and private borrowers, but the aim is not to explain why the government repays but to shown an alternative mechanism by which the default decision negatively impacts the relation between domestic private firms and foreign creditors. In an empirical paper, Arteta and Hale (2006) confirm this kind of effect and show that sovereign debt defaults increase the cost of foreign credit for private firms, even after controlling for the recessions and changes in fundamentals that accompany these episodes. The natural consequence of this fact is that sovereign and private spreads will be positively correlated.

This paper proposes a mechanism that can explain the observed correlation by using the exposure that domestic banks usually have to sovereign debt. In the model, firms have private information about the results of the projects financed by domestic banks and foreign creditors. Banks are the only agents able to verify, after paying the corresponding cost, the true result of the projects, and foreign credit is only possible if banks actually lend to domestic firms and have the incentives to verify their results. Therefore, any event that impacts negatively the domestic financial system, such as a sovereign default, and reduces its verification capacity would reduce payments to foreign creditors. As a consequence, sovereign default risk, private domestic debt default and private foreign debt default risk are positively correlated. The fact that governments default not only on foreign but also on domestic creditors obviously plays a key role in this model and is probably more suitable to describe the last generation of default episodes, where the fact that the sovereign debt's structure shows a higher significance of bonds makes it more difficult for the government to discriminate among creditors (Broner and Ventura 2005).

There are related papers that also explore the relation between sovereign and private default risks. In Arellano and Kocherlakota (2007), unlike in this paper, the default event starts in the private sector and transmits to the government through a decrease in tax revenues. Mendoza and Yue (2008) also present a model in which sovereign and private default risks are positively correlated, but they directly assume that governments and firms default together, without explaining why, as they are interested in studying other economic relations and generating quantitative results.

3.2 The Model

The model relates to Diamond (1984) in the fact that financial institutions have a better monitoring capacity that other agents, to Holmstrom and Tirole (1997) in the fact that domestic lenders haver better information than foreign ones, and to Arellano and Kocherlakota (2007) in the fact that the capacity of lenders to collect payments is reduced during a default. However, the origin of the crisis in this last model is different than the one exposed in this paper, which also presents a formal mechanism that explains the reduction in this capacity to collect payments.

3.2.1 Timing

The model consists of two periods

Period 1

1. The government issues debt B, which is placed in the domestic financial system
2. Financial Institutions raise 1-period deposits and allocate their assets among government bonds, 1-period loans to entrepreneurs (who can hide the results of their projects), and 1-period loans to firms that do not present information problems and whose results are i.i.d. (by the law of large numbers, we can say they represent a safe investment technology)
3. Entrepreneurs borrow from foreign investors and banks, and invest in their projects
4. Foreign investors lend to entrepreneurs
5. Domestic savers deposit their resources in domestic financial institutions

Period 2

1. Financial Institutions state if they will verify those entrepreneurs' projects that will be declared unsuccessful and commit to this decision
2. The government repays or repudiates its debt
3. Entrepreneurs see whether their projects resulted succesfull or unsuccesfull and announce a result

4. Financial institutions collect payments from entrepreneurs when projects are declared succesfull and verify results, if they decided to do so, when projects are declared unsuccesfull. They also collect the payments from their investments in the safe technology and repay to depositors.

5. Foreign investors collect payments from entrepreneurs.

3.2.2 Environment

The economy is populated by the government, entrepreneurs, domestic financial institutions and foreign investors[1], who have the characteristics described below.

Government

The government issues in period 1 an amount of domestic sovereign debt $B_1 > 0$, which can only be placed in domestic financial institutions, to cover the difference between spending and taxes plus foreign borrowing capacity. As the goal of the paper is not to explain why defaults occur but to propose a transmission mechanism from these events to the repayment of foreign credit by private firms, all fiscal variables are assumed to be exogenous. All domestic debt is composed by one period bonds that promise a gross rate of return R^G, promise honored with probability $1 - p_d$, and that pay nothing when the promise is not honored. The variable h takes a value of 1 if the debt is honored and 0 otherwise. Bondholders, who are risk neutral, get an expected return equal to that of a safe technology (R^*).

$$(1 - p_d) R^G = R^*$$

Entrepreneurs

There is a number E of entrepreneurs who are endowed in period 1 with a production technology. They do not have resources of their own, but if they are able to raise funds so as to invest 1 unit investment in fixed capital, in period 2 they get:

[1]Depositors and firms with no information problems are also agents in this economy, but their behavior is linear and they play a secondary role

R with probability p_H

0 with probability $1 - p_H$

Each project's realization, which is independent of the realizations of other projetcs, is observed by the entrepreneur and, as long as it pays a fixed verification cost V, by any domestic financial institution.

It is assumed that the expected rate of return of investment I is higher than safe technology's rate of return

$$p_H R > R^*$$

Domestic Financial Institutions

The domestic financial system consists of a number N of identical institutions. As these institutions behave competitively, we are going to express all variables as aggregate variables, having in mind that $\frac{1}{N}$ of each of them corresponds to an individual institution.

The financial system starts with an amount W_1 of own capital, raises as deposits D_1 the total savings of the economy (exogenous), buys B_1 government bonds (exogenous), lends S_1 to "transparent" firms, and lends C_1 to entrepreneurs with the ability to hide the results of their projects, unless institutions verify them. By identity

$$W_1 + D_1 = C_1 + B_1 + S_1$$

As the existence of bank runs would complicate the exposition of the model but would keep the main result unchanged, it is assumed that all the investment in risky assets is covered with the system's own capital and the proceedings from investment in transparent firms (by the law of large numbers, they provide the risk free interest rate R^* with certainty) are enough to repay depositors (who also receive the risk free interest rate, which is available for them if they invest abroad)

$$W_1 > C_1 + B_1 \implies D_1 < S_1$$

As said above, these domestic financial institutions have the ability to verify the results of entrepreneurs' projects and discover with certainty their true realizations. They incur in a cost V for each project they verify. So as to be able to verify all projects, they must count with the necessary resources after paying depositors and being paid by the government and transparent firms, but before being paid by entrepreneurs. We will assume that the only case in which they might fall short of resources is when the government repudiates its debt.

Foreign Investors

Foreign investors are competitive and risk neutral agents who can either lend to domestic firms or invest in a safe technology that pays a gross return $R^* \geq 1$ with certainty. They do not have the ability to verify the result declared by an entrepreneur in period 2, but they do observe if he is borrowing from a financial institution in period 1. Although the possibility of hiding the contract with the financial institution is not allowed in the model, it is worth noting that it would go against the own interest of the entrepreneurs, who as we will see later prefers to make public that it can be audited by a financial institution and, therefore, receive credit from foreign investors.

3.2.3 Optimization without Sovereign Default

Contracts between entrepreneurs and foreign investors, which can be signed after observing if the entrepreneur has a contract with a domestic financial institution, establish the credit granted to the entrepreneur (I^F) and the return paid to the foreign investor if the project is successful (R^F) Contracts between entrepreneurs and domestic financial institutions establish the funding provided by the last ones (I^B), the rate of return they must be paid if the project is reported as successful (R^B) and the amount the financial institution would collect if it finds out that a project declared unsuccessful was in fact successful. An optimal contract establishes that the entrepreneur obtains nothing if it is caught committing a fraud. We assume that, if this is the case, foreign investors and domestic financial institutions obtain a share in the result proportional to the share they had in the initial investment (foreigners receive $I^F R$ and domestic financial institutions $I^B R$)

Each project could be funded by domestic financial institutions, foreign investors or both, but we can rule out the possibility of projects being funded only by foreigners: as they cannot verify the true outcome, the entrepreneurs would always declare them to be unsuccessful and the investors will get a 0 return. As both type of creditors participate, we have

$$1 = I^B + I^F$$

Assumption 1 It is assumed that there is scarcity of projects: the lending capacity of domestic financial institutions is enough to cover all entrepreneurs' investment needs. As a consequence, expected rates of return for both domestic financial institutions and foreign creditors are equal to the risk-free rate of return (R^*).

Now, we present how an equilibrium with entrepreneurs telling the truth would look like and arrive to the necessary assumptions for it to happen. As we are in the no default case, financial institutions have a perfect verification capacity (they discover frauds with certainty).

Foreign investors collect the promised rate of return payment R^F when the project is successful and the condition for them to participate is

$$R^F \geq \frac{R^*}{p_H}$$

which is satisfied with equality.

Domestic financial institutions must cover both the opportunity cost of investing their funds in the safe technology and the verification cost

$$\begin{aligned} p_H R^B I^B - (1 - p_H) V &= R^* I^B \\ R^B &= \frac{R^*}{p_H} + \frac{1 - p_H}{p_H} \frac{V}{I^B} \\ R^B &> R^F \end{aligned}$$

Proposition 11 *In order to compensate financial institutions for the verification cost they would incur in if the project fails, the promised rate of return to them is higher than that promised to foreign investors. As a consequence, entrepreneurs will get as less funding as possible from domestic financial institutions.*

The equilibrium proposed is only possible if financial institutions do audit projects declared to be unsuccessful and entrepreneurs have then an incentive to tell the truth. The announcement of financial institutions at the beginning of period 2 that they will audit is only credible if they have invested enough in these projects so as to have large enough stakes in the eventual payment collection to justify paying the fixed verification cost.

Assumption 2 It is assumed that the financial institution makes at the beginning of period 2 a credible announcement that it will audit projects that were declared unsuccessful. For the announcement to be credible, the financial institution must invest in period 1 a minimum amount I_m^B, assumed to be higher than 0, such that its claims on the result are high enough to compensate the verification cost (V) it must incur in:

$$\begin{aligned} p_H I^B R &\geq V \\ I^B &\geq \frac{V}{p_H R} = I_m^B \end{aligned}$$

Proposition 12 *As funding from domestic financial institutions is more expensive than funding from foreign investors, entrepreneurs will take the lowest possible amount of credit from the first ones, conditional on them having an incentive to monitor ($I^B = I_m^B$). Foreign creditors provide the rest of the credit necessary to make the fixed investment: $I^F = 1 - I_m^B$*

Domestic financial institutions fund all available projects (E), providing each of them the minimum credit (I_m^B) that makes them willing to monitor in period 2, hold all government debt B and invest the rest of their assets in the safe technology. The total amount of credit provided to entrepreneurs is $C_1^T = EI_m^B$ and each institution provides $C_1 = \frac{E}{F} I_m^B$. By the law of large numbers, the return on the credit to entrepreneurs will be R^*, as well as the return of investments in the safe technology. In the case we are analyzing in this section, in which the government repays its debt, financial institutions' net worth in period 2 would be

$$\begin{aligned} W_2 &= R^* C_1 + R^G B_1 + R^* S_1 - R^* D_1 \\ W_2 &= R^* C_1 + R^G B_1 + R^* S_1 - R^* \left[C_1 + B_1 + S_1 - W_1 \right] \\ W_2 &= \left(R^G - R^* \right) B_1 + R^* W_1 \end{aligned}$$

Definition 13 ***Equilibrium*** *Entrepreneurs, domestic financial institutions and foreign investors maximize their expected return such that*

$$
\begin{aligned}
I^B(no\ default) &= \frac{V}{p_H R} \\
I^F(no\ default) &= 1 - \frac{V}{p_H R} \\
R^B(no\ default) &= \frac{R^*}{p_H} + \frac{1-p_H}{p_H}\frac{V}{I^B} = \frac{R^*}{p_H} + (1-p_H)\,R \\
R^F(no\ default) &= \frac{R^*}{p_H} \\
C_1(no\ default) &= E\frac{V}{p_H R} \\
W_2(no\ default) &= \left(R^G(no\ default) - R^*\right)B_1 + R^* W_1
\end{aligned}
$$

So as to check that the financial system counts with enough resources to monitor all entrepreneurs (so as to make the committment credible), we must have

$$
\begin{aligned}
R^*(S-D)) + R^G B_1 &> EV \\
R^*[W_1 - (C_1 + B)] + R^G B_1 &> EV \\
R^* W_1 + \left(R^G - R^*\right)B_1 - R^* E\frac{V}{p_H R} &> EV
\end{aligned}
$$

As we are in a no default case, $R^G = R^*$ and we must have $R^* W_1 > EV\frac{p_H R + R^*}{p_H R}$

3.2.4 Optimization allowing for Sovereign Default

The easiest way to present this case is by solving, from the beginning, the amount of credit that each entrepreneur demands from the domestic financial system and, as a consequence, the total amount of credit to entrepreneurs issued by the domestic financial system. With this magnitudes determined, we will analyze the impact that a sovereign default might have on the verification capacity of the financial system and the rates of return paid by entrepreneurs, both to domestic financial institutions and foreign creditors.

As in the previous case, we must find the minimum investment made in period 1 by a domestic financial institutions so that it has, in period 2, enough incentives to audit an entrepreneur that declares himself to be unsuccessful. This is the amount entrepreneurs will actually borrow from domestic financial institutions. It will be verified later that, as it has to compensate for the verification costs, domestic credit is more expensive and entrepreneurs will turn to foreign creditors once they have achieved the minimum requirement of domestic credit.

$$\begin{aligned} p_H I^B R &\geq V \\ I^B &\geq \frac{V}{p_H R} = I_m^B \end{aligned}$$

As the amount of credit provided to the entrepreneurs by the domestic financial system remains the same as in the case were the possibility of defaul was ruled out, the constraint that must be satisfied for the financial system to be able to audit entrepreneurs also remains unchanged

$$R^* W_1 + \left(R^G - R^*\right) B_1 - R^* E \frac{V}{p_H R} > EV$$

If the government repudiates its debt, the constraint becomes

$$R^* W_1 - R^* B_1 - R^* E \frac{V}{p_H R} > EV$$

It will be assumed that the financial system is in an intermediate situation: it is able to audit all entrepreneurs when the government repays but unable to do it when the government defaults.

$$R^* W_1 + \left(R^G - R^*\right) B_1 - R^* E \frac{V}{p_H R} > EV > R^* W_1 - R^* B_1 - R^* E \frac{V}{p_H R}$$

In the case of a sovereign default, domestic financial institutions can use all resources available and randomly verify the results of a fraction $p_v < 1$ of entrepreneurs, where

$$p_v = \frac{R^*W_1 - R^*B_1 - R^*E\frac{V}{p_H R}}{EV}$$

If this probability of being audited is enough for entrepreneurs to report the true realization of their projects, then we are in the same situation as before, with

$$\begin{aligned} R^B &= \frac{R^*}{p_H} + \frac{1-p_H}{p_H}\frac{V}{I^B} = \frac{R^*}{p_H} + (1-p_H)\,R \\ R^F &= \frac{R^*}{p_H} \end{aligned}$$

and no correlation between the rates of return promised by entrepreneurs and by the government. So as to introduce a more interesting situation, we make the assumptions necessary to rule out the possibility of entrepreneurs reporting the truth and having an equilibrium equivalent to the case were default was not possible

$$\begin{aligned} (1-p_v)\,R &> R - R^F(no\ def)I^F(no\ def) - R^B(no\ def)I^B(no\ def) \\ p_v R &< \frac{R^*}{p_H}\left[1 - \frac{V}{p_H R}\right] + \left[\frac{R^*}{p_H} + (1-p_H)\,R\right]\frac{V}{p_H R} \\ p_V &< \frac{R^*}{p_H R} + \frac{(1-p_H)\,V}{p_H R} \end{aligned}$$

In this scenario, all entrepreneurs will declare in period 2 that their projects were unsuccessful and financial institutions will audit a fraction p_v of them. Out of this audited projects, each of which implies for domestic financial institutions a cost V, a fraction p_H will turn out to be successful and the financial institution will be able to collect $I^B R$. With respect to foreign investors, they collect $I^F R$ when the project was declared unsuccessful but it turned out to be successful. As the expected return of lending to entrepreneurs must be equal to the risk-free rate of return, we have

$$
\begin{aligned}
R^{*}I^{F} &= (1-p_d)\left[p_H R^F I^F\right] + p_d\left[p_v p_H R I^F\right] \\
R^{*} &= (1-p_d)\left[p_H R^F\right] + p_d\left[p_v p_H R\right] \\
R^{F} &= \frac{R^{*}}{(1-p_d)\,p_H} - \frac{p_d p_v}{(1-p_d)} R
\end{aligned}
$$

and

$$
\begin{aligned}
R^{*}I^{B} &= (1-p_d)\left[p_H R^B I^B - (1-p_H)\,V\right] + p_d\left[p_v\left(p_H R I^B - V\right)\right] \\
R^{*} &= (1-p_d)\left[p_H R^B\right] + p_d\left[p_v p_H R\right] - \frac{V}{I^B}\left[(1-p_d)(1-p_H) + p_d p_v\right] \\
R^{B} &= \frac{R^{*}}{(1-p_d)\,p_H} - \frac{p_d p_v}{(1-p_d)} R + \frac{V}{p_H I^B}\left[(1-p_H) + \frac{p_d p_v}{(1-p_d)}\right]
\end{aligned}
$$

As stated above, $R^B > R^F$, which confirms that entrepreneurs borrow the minimum possible amount from domestic financial firms.

Proposition 14 *The rates of return promised to domestic financial institutions (R^B) and foreign creditors (R^F) are increasing in the probability of sovereign default (p_d), so sovereign spreads and interest rates charged to the private sector are positively correlated.*

The derivatives with respect to p_d are

$$
\begin{aligned}
\frac{dR^F}{dp_d} &= \frac{R^{*}}{(1-p_d)^2\,p_H} - p_v R\left[\frac{1}{1-p_d} + \frac{p_d}{(1-p_d)^2}\right] \\
\frac{dR^B}{dp_d} &= \frac{dR^F}{dp_d} + \frac{p_v V}{p_H I^B}\left[\frac{1}{(1-p_d)^2}\right] > \frac{dR^F}{dp_d}
\end{aligned}
$$

The condition under which $\frac{dR^F}{dp_d} > 0$ is

$$
\frac{dR^F}{dp_d} > 0 \iff p_v < \frac{R^{*}}{p_H R}
$$

and this condition also implies $\frac{dR^B}{dp_d} > 0$, as $\frac{dR^B}{dp_d} > \frac{dR^F}{dp_d}$

We can prove this condition is satisfied by analyzing the entrepreneur's reporting decision. We had assumed that the successful entrepreneur would report a failure in the case of a sovereign default, so

$$(1-p_v)\,R \geq R - R^F I^F - R^B I^B$$

As $R^B > R^F$, this implies that

$$\begin{aligned}(1-p_v)\,R &\geq R - R^B I^F - R^B I^B \\ p_v R &\leq R^B\end{aligned}$$

Replacing R^B

$$\begin{aligned}p_v R &\leq \frac{R^*}{(1-p_d)\,p_H} - \frac{p_d p_v}{(1-p_d)} R + \frac{V}{p_H I^B}\left[(1-p_H) + \frac{p_d p_v}{(1-p_d)}\right] \\ p_v &\leq \frac{R^*}{p_H R} + \frac{(1-p_d)\,V}{p_H I^B}\left[(1-p_H) + \frac{p_d p_v}{(1-p_d)}\right]\end{aligned}$$

which confirms that a higher sovereign default risk generates higher spreads for domestic entrepreneurs, both in their domestic and foreign debts. This happens only when domestic financial institutions are significantly exposed to sovereign debt: their holdings of government bonds are too large with respect to their own capital. Economies with stronger financial systems would present a lower correlation between sovereign and private spreads, or could even present no correlation at all. In this kind of economies, the sovereign default would not generate private defaults and the only ones affected would be those holding government bonds.

3.3 Conclusion

The model presents a mechanism by which sovereign defaults trigger private defaults and therefore rationalizes the observed fact that sovereign and private spreads move together. The exposure of domestic financial systems to sovereign risk, which is broadly observed, plays a determinant role in this mechanism.

In the model, the presence of information asymmetries between domestic and foreign creditors, with the first ones being able to verify the results of domestic projects and the second ones not, generates a key dependency: foreigners only lend if domestic banks do it as well and the interest rate they demand is lower when banks have a higher verification capacity. Events that deteriorate this verification capacity, as sovereign defaults in economies where domestic banks are largely exposed to sovereign risk, would trigger defaults by domestic private creditors on their foreign debts. Therefore, there exists a positive correlation between interest rates charged to governments and private firms of the same countries, and the correlation increases as financial systems become weaker.

An interesting extension of the model would be to endogeneize the behaviour of the government, allowing for example for partial defaults. This would provide a possible explanation for the differences in the size of haircuts applied by different governments and how these differences relate to the strength of the domestic financial systems. Another interesting extension, in a framework of endogenous government's behaviour, would be to allow for the possibility of bank runs. This would generate another factor to be taken into account by the government at the time of deciding how much to repay and incorporate a fact observed in several cases of sovereign defaults.

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